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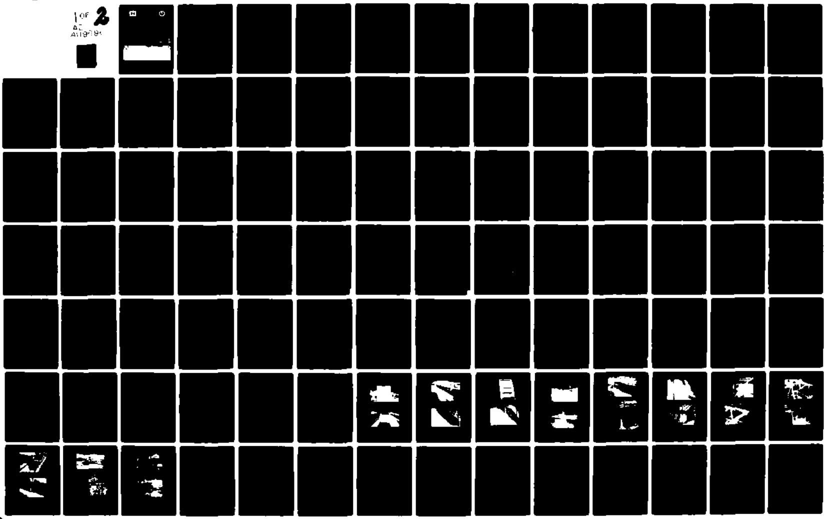

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MISCELLANEOUS PAPER SL-82-4

CONDITION SURVEY OF CEDARS LOCK AND DAM LOWER FOX RIVER, WISCONSIN

by

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Final Report

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A condition survey was performed at Cedars Lock and Dam on the Lower Fox River, Wisconsin. The field investigation included drilling for core samples of concrete, foundation rock, and backfill. Selected specimens of these materials were tested in the laboratory for certain physical and mechanical properties. Results of the field investigation and laboratory tests indicated that the concrete in the lock and dam is locally cracked and lightly deteriorated but structurally sound.

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20. ABSTRACT (Continued)

Rock masonry in the lock appears sound even though the outside surface is weathered. Cycles of freezing and thawing have caused the deterioration. The lock and dam is founded on competent bedrock. No soft or otherwise weak zones were detected in the bedrock. Soundings should be made to detect any scouring behind the dam. It is suggested that the reinforcing steel in the tainter gate piers, adjacent to the hinge pins, be examined for corrosion.

PREFACE

The investigation described herein was performed for the U. S. Army Engineer District, Chicago, by the U. S. Army Engineer Waterways Experiment Station (WES). The work was authorized by DA Form 2544, No. NCC-IA-80-57, dated 19 March 1980.

The testing program was accomplished under the direction of Mr. Bryant Mather, Chief of the Structures Laboratory (SL), WES, and Mr. John M. Scanlon, Jr., Chief of the Concrete Technology Division (CTD), SL. The core drilling was conducted by the Geotechnical Laboratory (GL), WES, under the direction of Mr. Mark A. Vispi. Laboratory work in the CTD was done with the assistance of Mr. F. S. Stewart and Mrs. Joyce C. Ahlvin. Mr. R. L. Stowe was Project Leader for the investigation. Mr. Stowe and Mrs. Ahlvin prepared this report.

Funds for publication of the report were provided from those made available for operation of the Concrete Technology Information Analysis Center (CTIAC). This is CTIAC Report No. 52.

Commanders and Directors of WES during the conduct of the investigation and the publication of this report were COL N. P. Conover, CE, and COL T. C. Creel, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, INCH-POUND TO METRIC (SI) UNITS OF MEASUREMENT

Inch-pound units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	0.0254	metres
miles (U. S. statute)	1.609347	kilometres
pounds (force) per square inch	0.006894757	megapascals
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre
tons (force) per square foot	0.09576052	megapascals

CONDITION SURVEY OF CEDARS LOCK AND DAM

LOWER FOX RIVER, WISCONSIN

PART I: INTRODUCTION

Project Description

1. The following general description of the Cedars Lock and Dam is taken from Reference 1.

> "The headwaters of the Fox River rise in Columbia County, Wisconsin, and flow in a Northeasterly direction for about 176 miles into Green Bay. The section of the river from Lake Winnebago to Green Bay is generally referred to as the Lower Fox River and is 39 miles long. It has a change in gradient of about 168 feet; channel widths are generally 500 to 1000 feet and minimum channel depths are 9.6 feet below Depere Lock and 6 feet below Menasha Lock. Upper pool El. 698.66 and lower pool El. 688.88 are referred to mean water level at Fathers Point, Quebec I.G.L.D. (1955) (Interntaional Great Lakes Datum)."

2. The Cedars lock is of masonry design and founded directly on dolomite. It has usable lock dimensions of 35 by 144 ft;* the lift is 9.8 ft at normal river stage.

3. The Cedars dam is of concrete gravity wall design and is keyed into the dolomite foundation. The dam consists of a 263.3-ft long spillway on the right side of the dam and a 211.0-ft long spillway on the left side of the dam. The midsection of the dam is a 180.0-ft long sluiceway containing seven tainter gates. Crest elevation** of the spillway sections is 698.66 (IGLD 1955); for prior datum planes, add 1.75 ft.

Location of Study Area

4. The Cedars Lock and Dam is located approximately 27.5 miles

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* A table of factors for converting inch-pound units of measurement to metric (SI) units is presented on page 3.

** All elevations (el) cited herein are in feet referred to I.G.L.D. 1955 (International Great Lakes Datum).

from the mouth of the Fox River at Green Bay. The lock and dam is situated on the river between the towns of Little Chute and Kimberly. A general plan view of the site is given in Plate 1; this plate is duplicated from Reference 1.

Background

5. In March of 1980 the Waterways Experiment Station (WES) was requested by the U. S. Army Engineer District, Chicago (NCC for North Central Division, Chicago), to review a number of documents, References 1,2, and 3, and submit a proposal for a condition survey of Cedars Lock and Dam. Reference 3 contained a preliminary exploration and testing program which was used as guidance in developing the WES proposal. The amount of exploration and testing that could be accomplished was governed by available funding.

6. After the drilling was initiated, District technical staff increased the number of borings. The added borings were drilled and some of the funding allocated for laboratory testing and reporting was diverted to cover the increased drilling cost. The reasons for increasing the number of borings was twofold; first, additional foundation information would be obtained for developing geologic profiles. Secondly, by drilling additional borings with the on-site marine floating plant, crane, etc., cost of mobilization and demobilization would not be incurred for a second drilling effort. The bedrock core from these added borings is preserved at the WES in case further testing is required. It was decided not to drill the lock masonry for fear of creating leaks along the mortar joints.

7. Work on this project was initiated by the Chicago District prior to the 1980 realignment of North Central Division. Work continued under the direction of the Chicago District although the Detroit District is now responsible for the geographical area that includes the Lower Fox River.

Objective

8. The objectives of this study were to evaluate subsurface conditions, to assess the in-place concrete conditions, to ascertain selected physical properties of concrete and rock, and to evaluate this information in order that design parameters be presented as guidance for a structural stability analysis. In addition, selected physical properties of backfill materials are to be determined. The Detroit District is scheduled to perform the stability analysis.

Scope

9. The report discusses the drilling effort involved in obtaining samples of soil, concrete, and rock. The physical condition of the in-place exposed concrete is described using a limited amount of information. Selected physical properties of the core samples were determined using standard Corps of Engineers test methods. A limited number of borings were drilled behind the sluiceway dam section for purposes of detecting possible covered scouring. A study was made to consolidate and evaluate engineering information, geologic and boring data, and laboratory test data as they relate to the foundation condition. Available construction and engineering data records were reviewed.

PART II: PRELIMINARY STUDY

Review of Records and Drawings

10. The author made a visit to the Kaukauna Project Office to review available engineering and construction drawings in the hope of finding foundation information. Very little information was available. Construction drawings, records, and photographs do not provide much information about the foundation condition. The drawings and photographs indicated that the lock and dam was founded on "nearly horizontal limestone rock."

11. Right-of-way fly-over photographs of the Lower Fox River were studied for indications of geologic structures such as joint systems and faults. The photographs were helpful in showing the plate-like bedding near the lock and dam. No indications of faulting were detected in the photographs or on topographic maps of the area. To the Kaukauna Project Engineer's knowledge, scour profiles had not been taken at Cedars Lock and Dam; in addition, scour holes behind the dam had not been detected.

Inspection of Lock and Dam

12. The author and Mr. Steve Running of the Kaukauna Project Office made an inspection of the Cedars Lock and Dam site. The main purpose of the inspection was to determine if macroscopic misalignment, settlement, expansion, or contraction of the concrete and masonry structures could be detected. The lock backfill was observed for settlement. The surface condition of the concrete was observed and boring locations assigned.

Lock chamber walls

13. No misalignment, settlement, or contraction of the masonry walls was detected. Expansion of the masonry occurred at exposed edges of some of the rock blocks, the expanded portions of the blocks being adjacent to block joints. This expansion is not viewed as a problem.

The top of the lock walls has been resurfaced with concrete and is in good condition. The lock masonry walls appear structurally sound and should function for a long time as originally intended. The stairways at the downstream end of the lock are in poor condition.

Lock embankment

14. The grassed embankment adjacent to both lock walls appears in good condition. The grassed area between the toe of the embankment against the riverside lock wall and the river shows a little differential settlement in the order of 6 to 10 in. The lockmaster said that small holes occasionally developed in the area and that the ground becomes spongy to walk on. He did not specify what conditions prevailed when the ground was spongy. Photographs No. 1 through 8 (see Appendix A) show the general condition of the lock walls and the embankment.

Dam, left abutment
wall, and spillway

15. Photographs 9 and 10 show the frost damaged concrete in the left abutment wall. There was no evidence of misalignment, settlement, or contraction in the dam sections. Slight expansion of local areas exists in the concrete due to the results of freezing and thawing action.

Dam, left spillway

16. The concrete in the foot bridge piers appears in good condition. See Photograph 11.

Dam, sluiceway

17. The condition of the concrete in the sluiceway piers is generally good (see Photographs 12 through 15). Damage due to freezing and thawing is confined to local areas. Minor amounts of concrete in the piers at low pool elevation have been abraded by water and ice action. Cracking through the piers near the gage hinge piers is present in each pier. Some piers are cracked through near the steps. The Chicago District conducted an analysis of the cracked concrete piers and determined that reinforcement within the piers was effective for gate loads; see Reference 1, Appendix B, page 13.

18. It is suggested that a study be made to determine if the reinforcing steel in the sluiceway piers is rusted. Infiltrating water along

the cracks could have caused reinforcement to rust. The concrete from around the downstream side of the gate hinge pin could be excavated to examine the reinforcing steel.

Dam, right abutment wall

19. The concrete in the right abutment wall is in good condition. A diagonal crack exists in the upstream portion of the wall and a near vertical crack exists in the downstream portion of the wall. The cracks appear to go through the wall. See Photographs 16 through 18.

20. During the inspection trip a visit was made to a quarry about 1/4 mile from the Lower Fox River. The rock here is believed to belong to the same formation (Galena-Platteville Dolomite) that exists beneath the Cedars Lock and Dam. Photographs 21 and 22 give a general and close-up view, respectively, of the quarry rock. The quarry floor and benches are bedding planes which are nearly horizontal.

21. Photographs 21 and 22 were taken in the dry dock area at the Kaukauna Project Office. A gate wall is seen founded on the bedrock.

PART III: FOUNDATION EXPLORATION

Previous Exploration

22. Presumably borings were taken prior to construction in the early 1930's. However, no information derived from such borings was available for review.

Current Drilling

23. Drilling equipment consisted of an Acker Toredo Mark II and a Sprage and Henwood skid-mounted rotary drill rig. A Diamond Core Drill Manufacturers Association standard 4-in. by 5-1/2-in. double tube swivel tube core barrel was used with diamond bits to obtain the concrete and bedrock core. Access to the drill holes was by a marine floating plant and for holes on top of structures by crane. Floating plant was supplied by Kaukauna Project Office. Continuous samples were obtained in all borings. Appropriate size casing was set in the bedrock when necessary to keep a boring open. A Concord portable drill rig was used in drilling horizontal cores.

24. The boring location plan is presented in Plate 2. A summary of boring information is given in Table 1; presented is the type boring, the location by structure, the elevation of the top of boring, the elevation top of rock, the elevation bottom of rock, and the date when the boring was started. The number of borings and boring locations were determined through mutual agreement by the Chicago District and the WES technical staff. Specific boring locations at the lock and dam were assigned by Mr. Stowe of the WES.

25. Two borings were put through the backfill and into bedrock; one boring was drilled on either side of the lock walls. Bedrock was sampled to a depth of 5.1 ft in the landside boring and to a depth of 26.7 ft in the riverside boring. A piezometer was installed in the riverside boring (C WES El-80). It was set at el 682.2 (piezometer tip). Pertinent piezometer data were presented in Plate 3. Piezometer readings

were not taken by the WES drill crew. The deeper borings into bedrock were carried from 21 to 29 ft deep. The shorter scour borings were taken about 6 ft into rock.

26. Boring C WES D2-80 was left open while the drill crew remained on site. Water level readings were taken by the lockmaster for a short period of time. The water level readings are presented in Table 2.

27. Total footage drilled was 36.0, 68.75, and 157.5 ft, respectively, for soil, concrete, and bedrock. All soil, concrete, and bedrock was preserved for possible laboratory testing, the exception being the highly fractured, broken samples. Procedures for preserving and handling the samples are present in References 4 and 5. Color photographs of the core are presented in Exhibit A. Field drilling logs are presented in Appendix B.

28. Core recovery was good in all borings indicating the general good condition of the materials drilled at the lock and dam sites; core recovery averaged 98.4 percent. Drilling water loss was very small and restricted to several locations. In boring D3 at el 681.8 to 682.4 water loss occurred. This zone was bounded by shale seams with black surface staining.

Scour Detection

29. Scour borings were located behind the sluiceway dam section. It was felt that this section of the dam would likely contain covered scour areas if any exist. The four borings behind the sluiceway section did not reveal any covered scour areas; no evidence of displaced or recently (postdam construction) disoriented rock blocks was found.

30. Because of the limited number of borings drilled behind the dam and the fact that scour profiles have not been taken, scouring of the bedrock behind the dam could exist. It is suggested that scour profiles be made. Undercutting of the toe of the dam should likewise be studied.

PART IV: GEOLOGICAL CHARACTERISTICS

Geomorphology

31. Cedars Lock and Dam is located in Outagamie County, Wisconsin, in the lowland between Green Bay and Lake Winnebago. This geographic province of Wisconsin is termed the Eastern Ridges and Lowlands and covers an area of 21,000 square miles, including the 7,500 square miles under Green Bay and Lake Michigan. It is bounded on the east by the lowland of Devonian shale now submerged beneath Lake Michigan and on the north by Green Bay. The western border is found along the contact of the Cambrian sandstone with the Lower Magnesian limestone from the Menominee River (Marinette County) to the Wisconsin River (Sauk and Columbia Counties). On the south the region is delineated by the terminal moraine at the edge of the most recent drift sheet and the Rock River below Jonesville.

32. Once much smaller than at present, the Lower Fox River valley was carved to its present size by the glacier. The immense ice sheet advanced southward cutting out the valley of Lake Michigan, while a tongue cut Green Bay Valley to its present dimensions. A medial moraine, the Kettle Range, was formed on the peninsula between Green Bay and Lake Michigan.

33. The retreat of the glacier, coupled with its cutting action, created a depression at Green Bay. The valley floor rises steeply with Lake Winnebago being 166.7 ft above Green Bay. This caused the Wolf and Upper Fox Rivers to change course and flow into the newly formed valley. Evidence of this can be seen in studies of the ancient shore of Lake Michigan by tracing red clay deposits. Lake Winnebago formed more recently by the deposition of glacial drift in the valley.

34. The western slope of the Upper Fox River valley is gentle, while the eastern slope is quite steep. Cliffs on the east are cut through the Cincinnati shales and Niagara dolomite and extend from Green Bay south past Lake Winnebago. The bedrock at the dam is the

Galena-Platteville dolomite of Ordovician age. All field boring logs identify bedrock as limestone; subsequent petrographic examination shows the bedrock to be dolomite.

Backfill

35. The backfill on either side of the lock is considered as construction fill. Profiles of borings E1 and E2 are presented in Plate 4. The backfill consists of inorganic clays, gravelly clays, and sandy clays; beneath these fine-grained soils is a strata (about 2.5 ft) of coarse-grained soil in the SC group. Beneath the soils is a layer of dolomite cobbles and boulders mixed with clay. The dolomite bedrock underlays the fill. The rock symbols used in the profiles in Plate 4 are for limestone; the symbols should be for dolomite.

Bedrock Stratigraphy

36. The bedrock beneath Cedars Lock and Dam is of the Galena-Platteville formation of the Champlainian series of the Ordovician system. This formation is between 120 and 155 ft thick in this area, as reported by the Wisconsin Geological and Natural History Survey.

37. The dolomite is gray-green, fine to medium grained, dense, moderately hard to hard, shaley, and fossiliferous in places. Bedding is massive. Thin shale beds, laminae, and stringers are part of the rock fabric. The shale is gray-green and quite hard. The shale features range in thickness from 0.01 ft to 0.08 ft and occur continuously to a maximum of 0.5-ft separation. The shale occurs parallel to bedding.

38. There appear to be two types of bedding surfaces in the core; they are designated Types A and B. Type A is irregular with semirounded peaks and valleys. Peak to valley distances range from 1/4 to 1/2 in.; periods are about 2 in. Type A surfaces are tightly interlocked and are the predominant type of bedding surface. Type B is almost planar, yet gently undulating with a few short asperities and steps; Type B bedding surfaces are interlocked. The thin hard shale is found on both types of

surfaces. A few stylolites exist in the core. Core breaks occur along the shale features. No soft, weak seams of shale or clay were detected in the core samples.

39. The dolomite contained infrequent solution cavities up to 0.05-ft diameter. With one exception, the cavities were filled with calcite. The cavities occurred between el 680 and el 684 and el 662 and el 670. One cavity in core D2 was filled with pyrite (at el 680.6). Staining appears in four of the cores (D4, D3, D5, E1) between el 666 and 667 and in three cores (D2, D3, D4) between el 684 and 685. In core D5 staining occurs from el 676.0 to 676.81. The staining and solution activity indicates that water has moved along bedding planes.

Geologic Cross Sections

40. Three geologic cross sections were drawn; sections A-A', B-B', and C-C' (see Plate 2 for cross section locations). Section A-A' (see Plates 5, 6, and 7) was drawn parallel to the dam axis and includes borings D3, D8, D2, D7, and D1. Section B-B' (see Plate 8) was drawn perpendicular to the lock, and section C-C' (see Plate 9) was drawn perpendicular to the dam at about its midlength. Section B-B' contains borings E1 and E2, and section C-C' contains borings D4, D2, D6, and D5.

Structure

41. The main structural feature in the bedrock is the nearly horizontal bedding. Hard shale beds, laminae, and stringers occur throughout the bedrock. However, the shale features are intact and intimately joined to the dolomite and considered a part of the rock fabric and are not considered individual troublesome units. There is no geologic feature within the bedrock that can be traced between borings.

42. The contact between the concrete and the bedrock core is well bonded except in cores D6 and D2. A complete separation exists in core D6 with brown calcite deposits on both surfaces. The calcite deposit indicates solution activity at the concrete-bedrock interface. Shale

pieces are embedded in the concrete to a shallow depth. A small amount of bedrock was probably left during cleanup prior to placing concrete. Evidence of solution activity is present in boring D2, again at the contact. Solution activity is present in the dam bedrock; however, it is not considered a problem at this time due to its apparent limited extent.

43. The extent of jointing in the bedrock could not be determined with the limited work done during this study. A total of four fractures (joints) were observed in the core. One short (1-ft long) vertical fracture exists in boring D3 at a midpoint el 684.2. Three fractures inclined at 45 deg from the horizontal were observed, one each in boring E2, D1, and D4. Jointing appears not to be a problem at the lock and dam in terms of stability of the two structures.

PART V: TESTS, TEST RESULTS, AND DISCUSSION

Test Specimens and Test Procedures

Cores received

44. Disturbed and undisturbed soil samples were recovered from the two backfill borings. The undisturbed samples consist of 14 steel tubes; the disturbed samples consist of 15 jars and 3 bags. Two boxes contained core samples. Table 3 describes the drill hole number, sample number, type sample, sample depth, and the material description of the soil samples received at the WES.

45. In addition to the soil samples, concrete and rock samples from 11 borings were received at the WES. Shipment of the materials was by government motor freight. All samples were received in good condition, and no sample breakage was detected. Pertinent information concerning the concrete and rock samples is presented in Table 4.

Selection of test specimens

46. Disturbed and undisturbed samples from borings E1-80 and E2-80 were examined and representative samples were chosen for general engineering type testing.

47. A detailed visual examination of core was made in the laboratory to supplement the field boring logs and to assist in the selection of representative test specimens. Concrete specimens were selected for testing based upon physical condition of the concrete and depth in order to obtain representative properties throughout the structure.

48. Three concrete specimens were selected from boring D2; one at the top, middle, and bottom of the boring. Test specimen depths shown in the tables of test results represent the midsection of the test specimen; e.g., el 696.5 is the midpoint of a piece of core with top el being 697.0 and the bottom el being 696.0. Both 6-in. and 4-in.-diameter concrete cores were used for testing. Four-inch-diameter rock cores were tested.

49. An attempt was made to select test specimens to be representative of the bedrock in close proximity to the base of the structure. The

test assignment locations can be obtained from appropriate tables of test results as well as from appropriate geologic cross sections.

50. Test specimens were selected for testing concurrent with the detailed logging of core; the logging began the day core arrived at the laboratory. The test specimens were rewrapped and stored in a moist curing room until time for testing; the moist room is maintained at 73.4 ± 3 F (23 ± 1.7 C).

Laboratory testing program

51. Soil samples. The testing of the soil samples consisted of the following.

a. Gradation Curve.

b. Atterberg Limits Testing.

c. Triaxial, $\bar{R}$.

d. Direct Shear.

52. Concrete cores. The testing program of the concrete cores consisted of the following tests on representative selected cores.

a. Unit Weight, γ .

b. Compression Wave Velocity, V_p .

c. Compressive Strength.

d. Water Content, w .

e. Elastic Moduli, E .

f. Poisson's Ratio, ν .

53. Rock cores. The testing of the bedrock cores consisted of the following tests on representative selected cores. The tests are grouped under either characterization tests or engineering design tests.

a. Characterization tests.

(1) Effective (As Received) and Dry Unit Weight, γ_m and γ_d .

(2) Water Content, w .

(3) Compressive Strength, q_u .

b. Engineering design tests.

(1) Elastic Moduli, E .

(2) Poisson's Ratio, ν .

(3) Triaxial Strength.

(4) Direct Shear Strength.

(a) Concrete on rock, precut (residual).

(b) Intact (maximum).

(c) Rock on rock, precut (residual).

(d) Cross bed (maximum).

Test procedures

54. The soil testing was accomplished according to EM 1110-2-1906, Laboratory Soils Testing. The characterization properties tests and the engineering design properties tests were conducted in accordance with the appropriate test method tabulated below:

Property	Test Method
Characterization	
Effective Unit Weight (As Received), γ_m	RTM 109-77*
Dry Unit Weight, γ_d	RTM 109-77
Water Content, w	RTM 106-77
Compressional Wave Velocity, V_p	RTM 110-77 (ASTM D 2845)
Compressive Strength, q_u	RTM 111-77 (ASTM D 2938)
Engineering Design	
Elastic Modulus, E	RTM 201-77 (ASTM D 2148)
Direct Shear Strength	RTM 203-77
Poisson's Ratio, ν	RTM 201-77
Triaxial Strength	RTM 202-77

* Reference 5.

55. For the compression and triaxial compression test, the specimens were cut with a diamond-blade saw and the cut surfaces were ground flat to 0.001 in.; specimens were checked for parallel ends and the perpendicularity of ends to the axis of the specimen. Electrical resistance strain-gages were used for strain measurements. Two each were used in the axial and horizontal directions. The modulus of elasticity and Poisson's ratio were computed from the strain measurements. Axial specimen load was applied with a 440,000-lbf capacity universal testing machine. Confining pressure during the triaxial tests was applied using an electro-hydraulic pump.

Soil Properties

56. All of the laboratory test data from soil samples are presented in Plates 10 through 18. The data consist of the following:

a. Boring E1-80.
   (1) One Atterberg Limits, classification (sieve analysis).
   (2) One $\bar{R}$ triaxial test.
   (3) One direct shear test.

b. Boring E2-80.
   (1) Three Atterberg limits, classification (sieve analysis).
   (2) One $\bar{R}$ triaxial test.

This report does not present an interpretation or recommended design parameters for the materials in the backfill because of various unknowns. We don't know what type of slope stability analysis will be used by the district, where the failure plane will be assumed within the backfill, and whether the bedrock will be incorporated in the analysis.

Concrete Test Results and Discussion

57. The following comments pertain to the condition of the concrete in the dam. These comments are the results of examination of the core recovered at the dam. The condition of the exposed concrete is discussed in Part II of this report. The concrete characterization and engineering design test results are presented in Table 5.

58. The concrete recovered from borings is nonair-entrained. It is light gray-brown, hard, dense, contains natural dolomite aggregate 1 in. in maximum size that is rounded to subangular. The concrete contains occasional entrapped air voids from 1/4 to 1/2 in. in size and is well consolidated. A few gravel pockets occur (honeycombed areas), but they do not affect the structural integrity of the concrete. Minor amounts of white reaction products were found throughout the concrete. The white reaction material probably resulted from alkali-silica reaction and is an alkali carbonate. At this time the concrete is not

adversely affected by the process producing the white reaction product, nor will it be in the near future. The concrete in the dam is structurally sound and should serve its intended purpose. The exceptions are those local areas where frost-damaged concrete exist.

59. The horizontal core recovered from boring D11 contains fractures throughout its 3-ft depth. The core was taken from the south side of sluiceway pier 3 about 1.5 ft downstream of the gate hinge pin. The factures could have occurred when the through cracks in the pier, near the gage hinge pin, developed. Some of the fractures are closed while some are open. The open fractures could be filled with a sealing agent to prevent water from penetrating the concrete.

60. The author believes that there is no reason to immediately repair the cracked or frost-damaged concrete in the dam. Repair of these damaged areas could be performed during regular maintenance periods.

61. The average physical properties of the concrete are tabulated below along with selected statistics. Stress versus strain curves are presented in Plate 19 for the three concrete specimens tested:

Test	Average Value	Standard Deviation	No. Specimens
Wet Unit Weight, pcf	153.4	0.7	3
Water Content, %	5.1	0.2	3
Compressional Wave Velocity, fps	17,240	544	3
Compressive Strength, psi	7,602	1480	3
Modulus of Elasticity, x 10^6 psi	4.69	0.42	3
Poisson's ratio	0.20	0.06	3

62. The physical properties of the concrete are characteristic of good quality concrete. The standard deviations are considered small and indicative of uniform concrete properties.

Rock Test Results and Discussion

63. The results of the characterization properties tests are presented in Table 4 for the bedrock. Stress versus strain curves are

presented in Plates 20 and 21. The following tabulation presents a summary of the average characterization properties and selected statistics for the bedrock.

Test	Average Value	Standard Deviation	No. Specimens
Effective Unit Weight, pcf	171.1	0.9	6
Dry Unit Weight, pcf	169.9	0.9	6
Water Content, %	0.7	0.2	6
Compressional Wave Velocity, fps	20,040	636	6
Compressive Strength, psi	20,050	2322	6
Modulus of Elasticity, x 10^6 psi	7.35	1.40	6
Poisson's Ratio	0.28	0.06	6
Shear Modulus, x 10^6 psi*	2.87	--	6

* Calculated using E and ν .

64. The tabulated rock properties are reasonable for the high quality bedrock beneath the Cedars Lock and Dam. The relatively low standard deviations for the different tests indicate consistency of the samples tested.

Maximum and residual
shear stress criteria

65. The following discussion of shear stress criteria is taken from Zeiglar (6) and is followed in this report.

66. Designers are commonly interested in the maximum available shear strength. The maximum shear stress points are identified as τ_{max} in Figure 1. The maximum shear stress usually corresponds to the peak of the shear stress versus displacement plot (curve a of Figure 1); however, some confusion may arise where strain-hardening is encountered. When strain-hardening occurs, an initial peak usually occurs at a relatively small displacement, followed by an increase in shear stress to a value greater than the initial peak. When this happens, the first peak is termed the maximum shear stress corresponding to initial failure and the latter is the ultimate shear stress.

67. If the residual shear strength is to be determined from the intact specimens, then displacement is continued until the shear stress

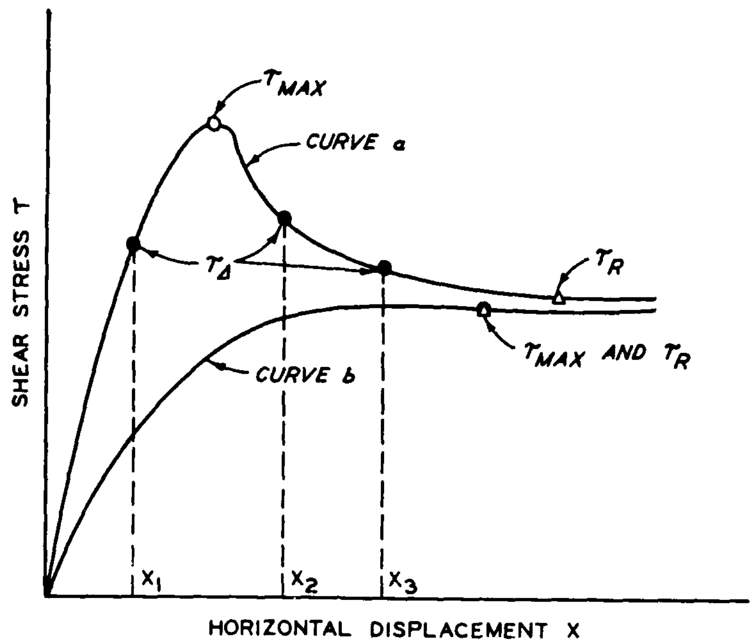


Figure 1. Maximum and residual shear stress, and displacement failure criteria, after Zeigler.

approaches the horizontal asymtotic value of residual shear stress τ_R (curve a of Figure 1). When the zone tested exhibits only a residual shear strength, curve b of Figure 1 may be obtained. In such cases, the maximum shear stress attained is the residual shear strength; precut specimens exhibit this type of curve. The shear strength obtained from precut specimens approaches the residual shear strength.

Maximum and residual shear strengths

68. Two types of direct shear tests were conducted to determine maximum strength of intact specimens and sliding friction properties of discontinuous specimens. Maximum strength was measured for intact dolomite parallel to and across bedding planes. Sliding friction properties were measured for specimens along precut surfaces, including concrete on rock and rock on rock. The direct shear test results of intact specimens are presented in Plate 22; shear stress values, load-deformation curves, and typical normal versus shear deformation curves are presented. The

direct shear test results from the discontinuous specimens tested as precut specimens are presented in Plates 23 and 24. Maximum and residual strength failure envelopes for the intact and discontinuous specimens are presented in Figure 2.

69. Intact specimens containing the two types of bedding surfaces were sheared parallel to bedding. The shear stress values obtained on specimens containing Type A surfaces were extremely high. The shear strength parameters for the Type A surfaces were ϕ = 81 deg and c = 198 tsf. The shear strength parameters for the Type B surfaces are lower: ϕ = 56.2 deg and c = 45.6 tsf. Specimens with both types of bedding surfaces had good shear breaks. The shear gap between the shear blocks was 1/16 in. The specimens sheared within this gap or within $\pm$3/16 in. of the gap.

70. Triaxial (TX) tests were performed on the dolomite to compare the angle of internal friction from TX to the relatively high friction angles obtained from the direct shear tests on surface Type A. Values of ϕ = 62 deg and a c = 198 tsf were obtained from the TX test results; see Plate 25. The results from the direct shear tests on the Type B bedding were judged to be appropriate.

71. Almost all shear failures of the intact specimens tested parallel to bedding were by breaking through the hard, thin shale features. Only a few asperities on the Type A surfaces sheared at the base. None of the asperities on the Type B bedding surfaces were sheared. As shear deformation occurred dilation began and one-half of the specimen rode up over the other. Attempts were not made to determine residual friction from the intact specimens. Precut rock specimens were used to determine the residual strength values. The sliding friction values for precut dolomite are ϕ = 29.7 deg and c = 0.

72. The interlocked bedding plane asperities and the inability to trace continuous bedding plane discontinuities across the site imply that any large-scale failure would involve substantial shearing of intact rock. Therefore, the residual value is not expected to control sliding beneath the lock or dam.

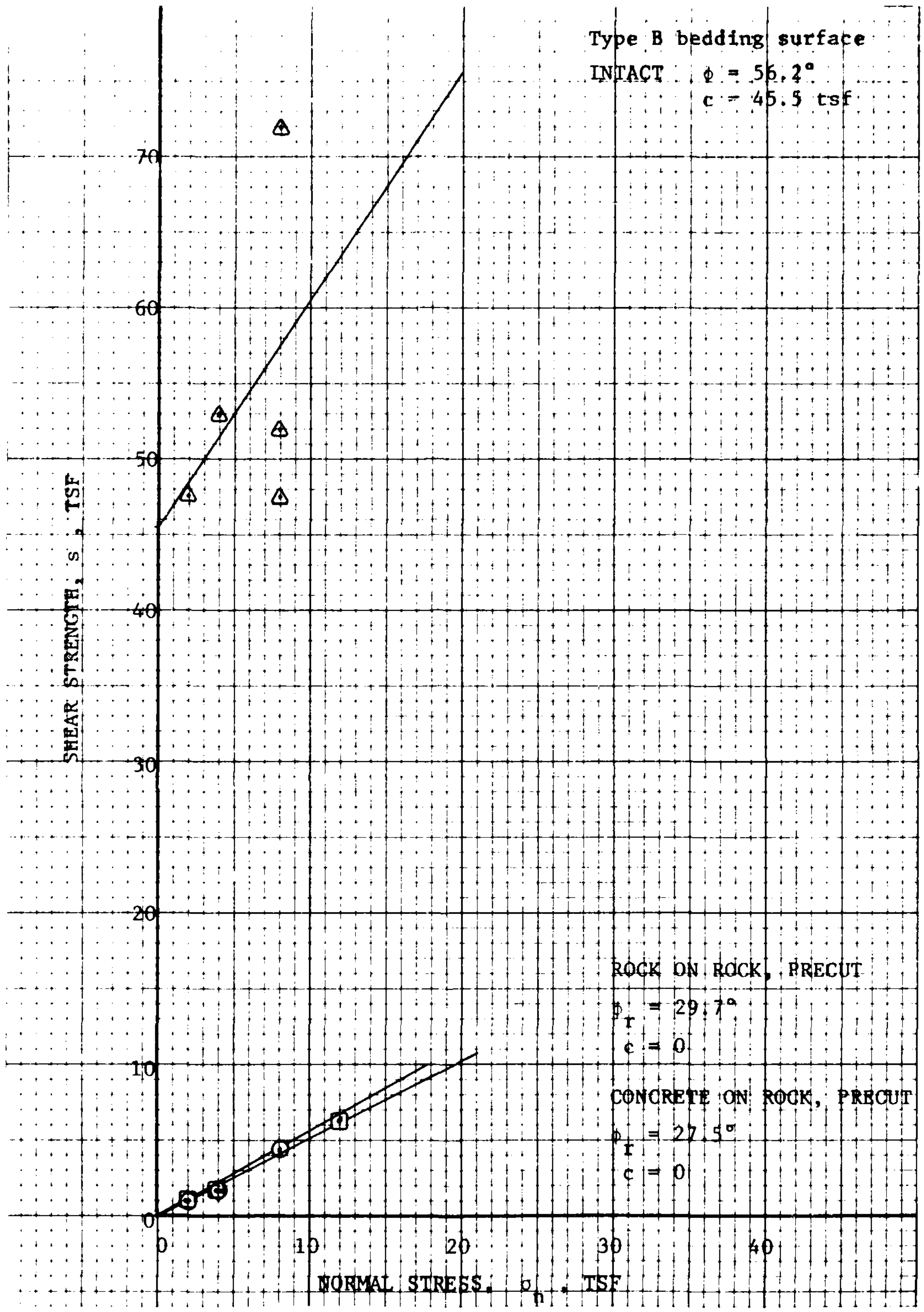


Figure 2. Direct shear test results, maximum and residual shear strength failure envelopes

73. After considering (a) the interlocking nature of the bedding surfaces, (b) the intimate and intact shale-dolomite rock fabric, and (c) because previously failed seams or indications of past horizontal movement in the bedrock were not observed, it is thought that peak shearing resistances of the shale features associated with the most nearly planar bedding surfa es (Type B) would control sliding. These peak shear strengths are recommended for computing stability, i.e., ϕ = 56 deg and c = 45.6 tsf.

74. Cross-bed shear tests were conducted (see Plate 26). The test results are widely scattered and no failure envelope was determined. It is suggested that cross-bed shear tests be performed in the future to determine this shear strength value. However, at this time it is considered reasonable to use the intact shear strengths for cross-bed shear strengths. Stagg and Zienkiewicz[7] state that:

> "When the directions of loading are such that the potential failure surfaces must cut across the structural features, the shear strength will approach that of the intact rock material."

Structural features, as mentioned in the quote from Stagg and Zienkiewicz, typically include joints, shear zones, and faults. At this site, the ubiquity of tightly interlocked asperities on the bedding planes justifies their inclusion in the class of "structural features" across which shear must occur.

Recommended Design Values

75. Design should consider the rock and the bedrock structural characteristics described herein. Guidance is presented in the following tabulation as to proper choice of design parameters:

Rock Property	Dolomite
Effective Unit Weight, lb/ft^3	171.1
Dry Unit Weight, lb/ft^3	169.9
Compressive Strength, psi	20,050
Shear Strength	
Intact, Type B bedding	$\phi = 56.2^\circ$ c = 45.6 tsf

Rock Property	Dolomite
Precut, rock on rock	$\phi_r = 29.7^o$
	$c = 0$
Precut, concrete on rock	$\phi_r = 27.5^o$
	$c = 0$
Cross bedded	$\phi = 56.2^o$
	$c = 45.6$ tsf
Triaxial Strength	$\phi = 62^o$
	$c = 198$ tsf
Modulus of Elasticity, x 10^6 psi	7.35
Poisson's Ratio	0.28
Shear Modulus, x 10^6 psi	2.87

Conclusions and Recommendations

76. Based upon a visual inspection of the lock and dam, core samples, and laboratory test results, the following conclusions seem warranted:

a. The rock masonry in the lock appears sound and has held up well in the severe winter conditions; it should continue to serve its original intended purpose, even though the outside surface is weathered.

b. The concrete in the lock and dam is locally cracked and lightly deteriorated. The deterioration is due to cycles of freezing and thawing. Each tainter gate pier has cracks adjacent to the hinge pins that go through the piers. The cause of these cracks is not postulated. The concrete in the dam is structurally sound and should continue to serve its originally intended purpose.

c. The lock and dam is founded on competent bedrock which contains a minimal number of discontinuities. Jointing is minimal. Shale features occur along irregular bedding planes; they are thin and considered as part of the rock fabric, and they should have no effect on sliding stability. No soft or otherwise weak zones were detected in the bedrock.

d. It is our opinion that no significant scour has occurred behind the dam. Sounding behind the dam should be made to verify this opinion.

e. We suggest that a study be conducted to ascertain if the reinforcing steel in the downstream portion of the tainter gate piers is badly corroded. An area around one of the hinge pins could be excavated for this purpose.

REFERENCES

1. U. S. Army Engineer District, Chicago, "Periodic Inspection Report No. 1," Cedars Lock and Dam, Lower Fox River, Wisconsin, Feb 1976.
2. Letter, NCCED-DC, dated 26 Dec 1979, subject "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures - Lower Fox River, Wisconsin, Appleton Locks and Dams;" attached to this letter is NCDED-T (26 Dec 79) 1st Ind, subject as above, and NCCED-DC (26 Dec 79) 2d Ind, subject as above.
3. Letter, NCCED-DC, dated 11 Mar 1976, subject "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures - Lower Fox River, Wisconsin, Cedars Lock and Dam;" attached to this letter is NCDED-T (11 Mar 76) 1st Ind, subject as above, DAEN-CWE-B (NCCED-DC, 11 Mar 76) 2d Ind, subject as above, NCDED-T (11 Mar 76) 3d Ind, subject as above, NCCED-DC (11 Mar 76) 4th Ind, subject as above, NCDED-T (11 Mar 76) 5th Ind, subject as above, NCCED-DC (11 Mar 76) 6th Ind, subject as above, NCDED-T (11 Mar 76) 7th Ind, subject as above.
4. U. S. Army, Office, Chief of Engineers, "Engineering and Design: Soil Sampling," EM 1110-2-1907, 31 Mar 72, U. S. Government Printing Office, Washington, D. C.
5. U. S. Army Engineer Waterways Experiment Station, CE, "Rock Testing Handbook," Test Standards - 1980, Vicksburg, Miss., Aug 1980.
6. Zeiglar, T. W., "In Situ Tests for the Determination of Rock Mass Shear Strength," TR No. S-72-12, Nov 1972, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
7. Stagg, K. G. and Zienkiewicz, O. C., Rock Mechanics in Engineering Practice, John Wiley and Sons, London, 1968, p 46.

Table 1

Boring, Locations, Elevations, and Starting Date of Boring

Cedars Lock and Dam, Lower Fox River

Boring No.	Type of Boring	Location	El Top of Boring ft	El Top of Rock ft	El Bottom of Boring ft	Start Date
C WES E1-80	▲̄	Backfill, LLW	704.00	686.60	659.90	2 Aug 1980
C WES E2-80	▲	Backfill, RLW	702.80	684.20	679.10	16 Aug 1980
C WES D1-80	⊕	Spillway Pier 1	703.80	686.20	666.10	12 Aug 1980
C WES D2-80	⊕	Sluiceway Pier 4	706.97	683.02	656.97	8 Aug 1980
C WES D3-80	⊕	Spillway Pier 7	703.80	686.60	664.75	13 Aug 1980
C WES D4-80	⊕	US of Sluiceway Pier 4	687.10	687.10	665.35	16 Aug 1980
C WES D5-80	⊕	DS of Sluiceway Pier 5	683.41	683.41	662.21	22 Aug 1980
C WES D6-80	⊕	DS Sluiceway Apron, Gate 4	686.91	685.46	682.11	19 Aug 1980
C WES D7-80	⊕	DS of Sluiceway Gate 1	685.91	685.91	679.71	23 Aug 1980
C WES D8-80	⊕	DS of Sluiceway Gate 7	686.26	686.26	681.06	22 Aug 1980
C WES D9-80	⊕—	Sluiceway Pier 4	697.33	--	697.33	22 Aug 1980
C WES D10-80	⊕—	Left Abutment	696.30	--	696.30	18 Aug 1980
C WES D11-80	⊕—	Sluiceway Pier 3	697.73	--	697.73	22 Aug 1980

⊕ Vertical 4-in. core hole.
⊕— Horizontal 4-in. core hole.
▲ Combined drive sample and core.
▲̄ Combined drive sample and core with piezometer installed.
LLW, Landside lock wall.
RLW, Riverside lock wall.
US Upstream.
DS Downstream.

Table 2

Water Level Readings

C WES D2-80

Time	Date	Upper Pool el, ft	Lower Pool el, ft	Top of Hole Elev, ft D2 (706.97) el, ft	Reading ft
3:30	19 Aug	699.52	689.91	690.37	-16.6
9:25	20 Aug	699.52	690.11	690.63	-16.34
3:30	20 Aug	699.52	690.11	690.62	-16.35
8:00	21 Aug	699.42	690.11	690.00	-16.97
5:00	21 Aug	699.42	690.11	690.33	-16.64
8:30	22 Aug	699.32	690.01	690.27	-16.70
5:25	22 Aug	699.32	690.01	690.27	-16.70
8:25	23 Aug	699.52	690.01	690.37	-16.60
3:30	23 Aug	699.52	690.01	690.25	-16.72

Table 3

Soil Samples Received, Cedars Lock and Dam, Lower Fox River

Date	Drill Hole No.	Sample No.	Type Sample	Sample Depth, ft	Material Field Nomenclature
		5-in. Steel Tube, 5-in. Piston Sampler, and 5-1/2- x 4-in. Core			
15 Aug 80	C WES E1-80	1A	5-in. steel tube	0.0 - 1.05	Organics, grass and roots
15 Aug 80	C WES E1-80	1B	Jar	1.05- 1.15	Gravelly clay, reddish brown
15 Aug 80	C WES E1-80	1C	5-in. steel tube	1.9 - 2.5	Gravelly clay, reddish brown
15 Aug 80	C WES E1-80	2A	5-in. steel tube	2.5 - 3.4	Clay
15 Aug 80	C WES E1-80	2B	Jar	3.4 - 3.5	Clay
15 Aug 80	C WES E1-80	2C	5-in. steel tube	3.5 - 4.4	Clay
15 Aug 80	C WES E1- 0	2D	Jar	4.4 - 4.5	Clay
15 Aug 80	C WES E1-80	3A	Jar	4.5 - 4.6	Clay w/one piece gravel
15 Aug 80	C WES E1-80	3B	5-in. steel tube	4.6 - 6.4	Clay
15 Aug 80	C WES E1-80	3C	Jar	6.4 - 6.5	Clay
15 Aug 80	C WES E1-80	4A	Jar	6.5 - 6.6	Clay
15 Aug 80	C WES E1-80	4B	5-in. steel tube	6.6 - 7.5	Clay, crumbly
15 Aug 80	C WES E1-80	4C	5-in. steel tube	7.5 - 8.4	Clay, crumbly
15 Aug 80	C WES E1-80	4D	Jar	8.4 - 8.5	Clay, crumbly
15 Aug 80	C WES E1-80	5A	5-in. steel tube	8.5 -10.4	Gravelly sand, clay
15 Aug 80	C WES E1-80	5B	Jar	10.4 -10.5	Gravelly sand, clay
15 Aug 80	C WES E1-80	6A	5-in. steel tube	10.7 -12.4	Gravelly sand, brown, fine to coarse
15 Aug 80	C WES E1-80	6B	Jar	12.4 -12.5	Gravelly sand, brown, fine to coarse
15 Aug 80	C WES E1-80	7	Splitspoon, jar	12.5 -14	Coarse sand
15 Aug 80	C WES E1-80		5-1/2- x 4-in. core	15.3 -20.3	Dolomite
15 Aug 80	C WES E2-80	1	5-in. steel tube	0.2 - 2.4	Organic matter, clay and silt, plastic, brown
15 Aug 80	C WES E2-80	1A	Jar	2.4 - 2.5	Organic matter, clay and silt, plastic, brown
15 Aug 80	C WES E2-80	2	5-in. steel tube	2.7 - 4.9	Clay/silt, brown, soft
15 Aug 80	C WES E2-80	2A	Jar	4.9 - 5.0	Clay/silt, brown, soft
15 Aug 80	C WES E2-80	3	5-in. steel tube	5.0 - 5.8	Clay, soft, reddish brown
15 Aug 80	C WES E2-80	3A	Jar	5.8 - 6.1	Clay, soft, reddish brown
15 Aug 80	C WES E2-80	3B	5-in. steel tube	6.1 - 7.2	Clay, soft, reddish brown
15 Aug 80	C WES E2-80	3C	Jar	7.2 - 7.3	Clay, soft, reddish brown

(Continued)

Table 3 (Concluded)

Date	Drill Hole No.	Sample No.	Type Sample	Sample Depth, ft	Material Field Nomenclature
		5-in. Steel Tube, 5-in. Piston Sampler, and 5-1/2- x 4-in. Core			
15 Aug 80	C WES E2-80	4	5-in. steel tube	7.6 - 8.5	Clay, w/dolomite, cobbles, boulders, gravel
15 Aug 80	C WES E2-80	4A	Jar	7.5 - 7.6	Clay, w/dolomite, cobbles, boulders, gravel
15 Aug 80	C WES E2-80	5	Bag - piston sampler	8.7 -11.4	Clay, w/dolomite, cobbles, boulders, gravel
15 Aug 80	C WES E2-80	6	Bag - piston sampler	11.4 -16.4	Clay (20%) dolomite (80%)
15 Aug 80	C WES E2-80	7	Bag - piston sampler	16.4 -18.7	Clay (20%) dolomite (80%)
15 Aug 80	C WES E2-80		Box, 5-1/2- x 4-in. core	18.7 -23.8	

Table 4

Samples Received at WES, Cedars Lock and Dam, Lower Fox River

WES Reference No.	Drill Hole No.	Date Received	Box No.	Depth ft	Pieces	Core Diameter in.
DET-5 DC-1-A	C WES E1-80	15 Aug 80	1 of 6	17.4 → 20.3	(1-5)	4
B			2 of 6	20.4 → 25.85	(1-6)	
C			3 of 6	25.85 → 30.4	(1-5)	
D			4 of 6	30.4 → 34.75	(1-5)	
E			5 of 6	34.75 → 39.7	(1-5)	
F			6 of 6	39.7 → 44.1	(1-7)	
DET-5 DC-2-A	C WES E2-80		1 of 1	(18.65 → 23.8)	(1-7)	
DET-5 CON-1-A	C WES D1-80		1 of 9	0.0 → 4.3	(1-2)	6
B			2 of 9	4.3 → 8.45	(1-4)	4
C			3 of 9	8.45 → 12.7	(1-3)	4
D			4 of 9	12.7 → 17.0	(1-3)	4
CON-1 DC-3-E			5 of 9	17.0 → 21.8	(1-6)	4
DET-5 DC-3-F			6 of 9	21.8 → 26.4	(1-6)	4
DC-3-G			7 of 9	26.4 → 30.3	(1-5)	4
DC-3-H			8 of 9	30.3 → 33.9	(1-4)	4
DC-3-I			9 of 9	33.9 → 37.3	(1-5)	4
DET-5 CON-2-A	C WES D2-80		1 of 11	0.00 → 4.55	(1-2)	6
B			2 of 11	4.55 → 9.10	(1-2)	4
C			3 of 11	9.10 → 14.10	(1)	4
D			4 of 11	14.10 → 19.15	(1-2)	4
E			5 of 11	19.15 → 23.95	(1)	4
DET-5 DC-4-F			6 of 11	23.95 → 29.20	(1-4)	4
G			7 of 11	29.20 → 33.80	(1-4)	4
H			8 of 11	33.80 → 38.20	(1-5)	4
I			9 of 11	38.20 → 42.00	(1-3)	4
J			10 of 11	42.00 → 46.50	(1-2)	4
K			11 of 11	46.50 → 50.00	(1-4)	4

(Continued)

Table 4 (Concluded)

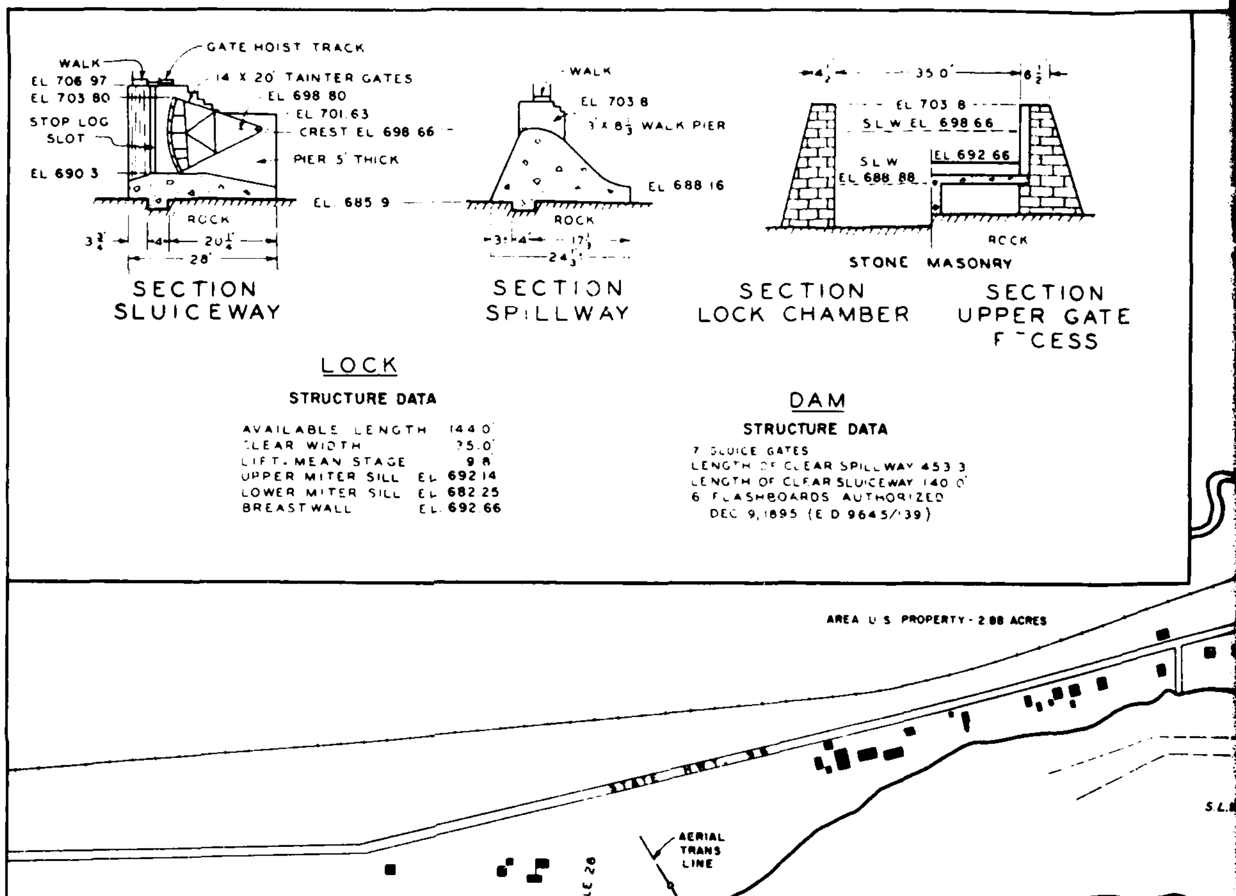
WES Reference No.	Drill Hole No.	Date Received	Box No.	Depth ft	Pieces	Core Diameter in.
DET-5 CON-3-A	C WES D3-80	15 Aug 80	1 of 9	0.0 → 3.45	(1-2)	6 and 4
B			2 of 9	3.45 → 8.1	(1-3)	4
C			3 of 9	8.1 → 11.2	(1-2)	4
D			4 of 9	11.2 → 15.75	(1-2)	4
CON-3- DC-5-E			5 of 9	15.75 → 20.6	(1-5)	4
DET-5 DC-5-F			6 of 9	20.6 → 24.5	(1-5)	4
G			7 of 9	24.5 → 29.5	(1-5)	4
H			8 of 9	29.5 → 34.4	(1-5)	4
I			9 of 9	34.4 → 38.6	(1-4)	4
DET-5 DC-6-A	C WES D4-80		1 of 5	0.0 → 4.9	(1-7)	4
B			2 of 5	4.9 → 9.4	(1-5)	4
C			3 of 5	9.4 → 13.95	(1-6)	4
D			4 of 5	13.95 → 18.2	(1-5)	4
E			5 of 5	18.2 → ?	(1-2)	4
DET-5 DC-7-A	C WES D5-80		1 of 5	0.0 → 4.40	(1-4)	4
B			2 of 5	4.40 → 9.4	(1-5)	4
C			3 of 5	9.4 → 14.45	(1-5)	4
D			4 of 5	14.95 → 17.95	(1-5)	4
E			5 of 5	17.95 → 21.2	(1-2)	4
DET-5 CON-4-A DC-8-A	C WES D6-80		1 of 1	0.0 → 4.85	(1-6)	4
DET-5 DC-9-A	C WES D7-80		1 of 2	0.0 → 3.55	(1-5)	4
B			2 of 2	3.55 → 6.2	(1-3)	4
DET-5 DC-10-A	C WES D8-80		1 of 1	(0.0 → 4.55)	(1-5)	4
DET-5 CON-5-A	C WES D9-80		1 of 1	0.0 → 2.85	(1-2)	4
DET-5 CON-6-A	C WES D10-80		1 of 1	0.0 → 2.85	(1-2)	4
DET-5 CON-7-A	C WES D11-80		1 of 1	0.0 → 2.95	(1-3)	4

Table 5

Concrete and Rock Core Test Results, Cedars Lock and Dam

Drill Hole No.	Elev ft	Characterization Tests: Depth of Core ft	Effective Unit Wt γ_m, lb/ft^3	Dry Unit Wt γ_d, lb/ft^3	Water Content w, pcf	Comp Wave Velocity V_p, fps	Comp Strength q_u, psi	Engineering Design Tests: Elastic Modulus $E \times 10^6$ psi	Poisson's Ratio
Concrete									
C WES D2-80	706.5	0.5	153.0	145.9	4.9	16,640	5,920	4.29	0.14
C WES D2-80	696.5	10.5	153.0	145.3	5.3	17,370	8,370	4.65	0.21
C WES D2-80	689.3	17.7	154.2	146.9	5.0	17,705	8,570	5.13	0.26
Avg			153.4	146.0	5.1	17,240	7,620	4.69	0.20
S*			0.7	0.8	0.2	544	1,480	0.42	0.06
Rock									
C WES D1-80	679.2	24.6	171.1	169.7	0.8	19,410	18,780	9.00	0.20
C WES D1-80	676.9	26.9	169.8	168.8	0.6	20,780	20,160	8.00	0.38
C WES D2-80	677.1	29.9	170.4	169.2	0.7	20,150	23,270	6.73	0.32
C WES D2-80	675.8	31.2	171.1	169.6	0.9	20,780	21,840	7.20	0.23
C WES D3-80	683.5	20.3	172.3	170.9	0.8	19,690	19,590	8.17	0.27
C WES D3-80	681.6	22.2	171.7	171.0	0.4	19,410	16,650	5.00	0.27
Avg			171.1	169.9	0.7	20,040	20,050	7.35	0.28
S			0.9	0.9	0.2	636	2,322	1.40	0.06

* Standard deviation.


WALK
GATE HOIST TRACK
EL 706 97
14 X 20' TAINTER GATES
EL 703 80
EL 698 80
EL 701.63
STOP LOG SLOT
CREST EL 698 66
PIER 5' THICK
EL 690 3
EL 685 9
ROCK
28'
SECTION SLUICEWAY
WALK
EL 703 8
WALK PIER
EL 688 16
ROCK
SECTION SPILLWAY
35 0'
EL 703 8
S L W EL 698 66
EL 692 66
S L W
EL 688 88
ROCK
STONE MASONRY
SECTION LOCK CHAMBER
SECTION UPPER GATE
LOCK
STRUCTURE DATA
AVAILABLE LENGTH 144 0'
CLEAR WIDTH 35.0'
LIFT - MEAN STAGE 9 8'
UPPER MITER SILL EL 692 14
LOWER MITER SILL EL 682 25
BREASTWALL EL 692 66
DAM
STRUCTURE DATA
LENGTH OF CLEAR SPILLWAY 453 3
LENGTH OF CLEAR SLUICEWAY 140 0'
6 FLASHBOARDS AUTHORIZED
DEC 9, 1895 (E D 9645/'39)
AREA U S PROPERTY - 2.88 ACRES
AERIAL TRANS LINE
MILE 28
(ROCK CUT)
FOX
DOCK
PARK
RAMP
SUNSET POINT
KIMBERLY-CLARK CORP PAPER WASTE TREATMENT FACILITIES
CHARLES
POND
WATER TOWER
JAMES
JOHN
SIDNEY
CLARK
VILLAGE HALL
RAILROAD

1

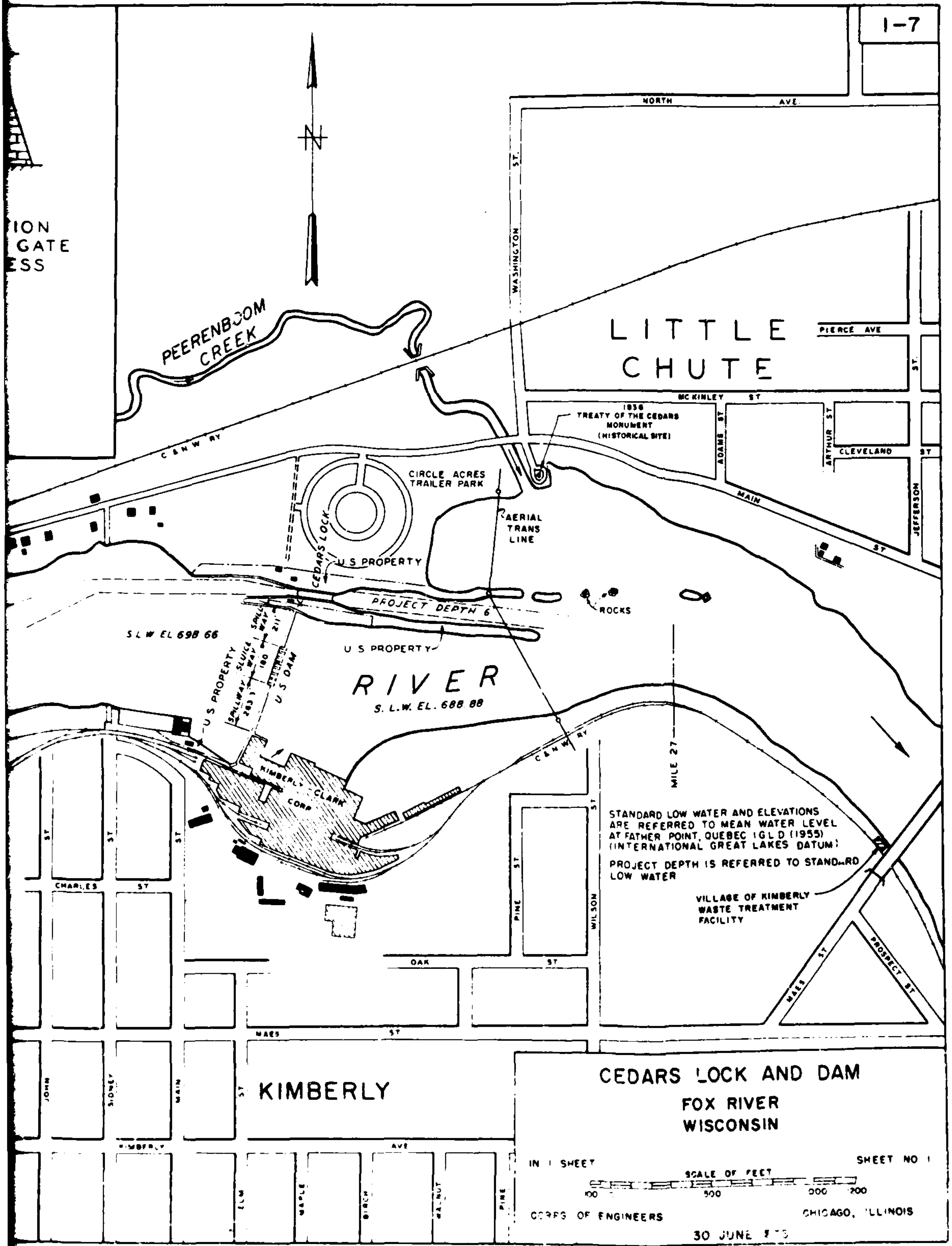
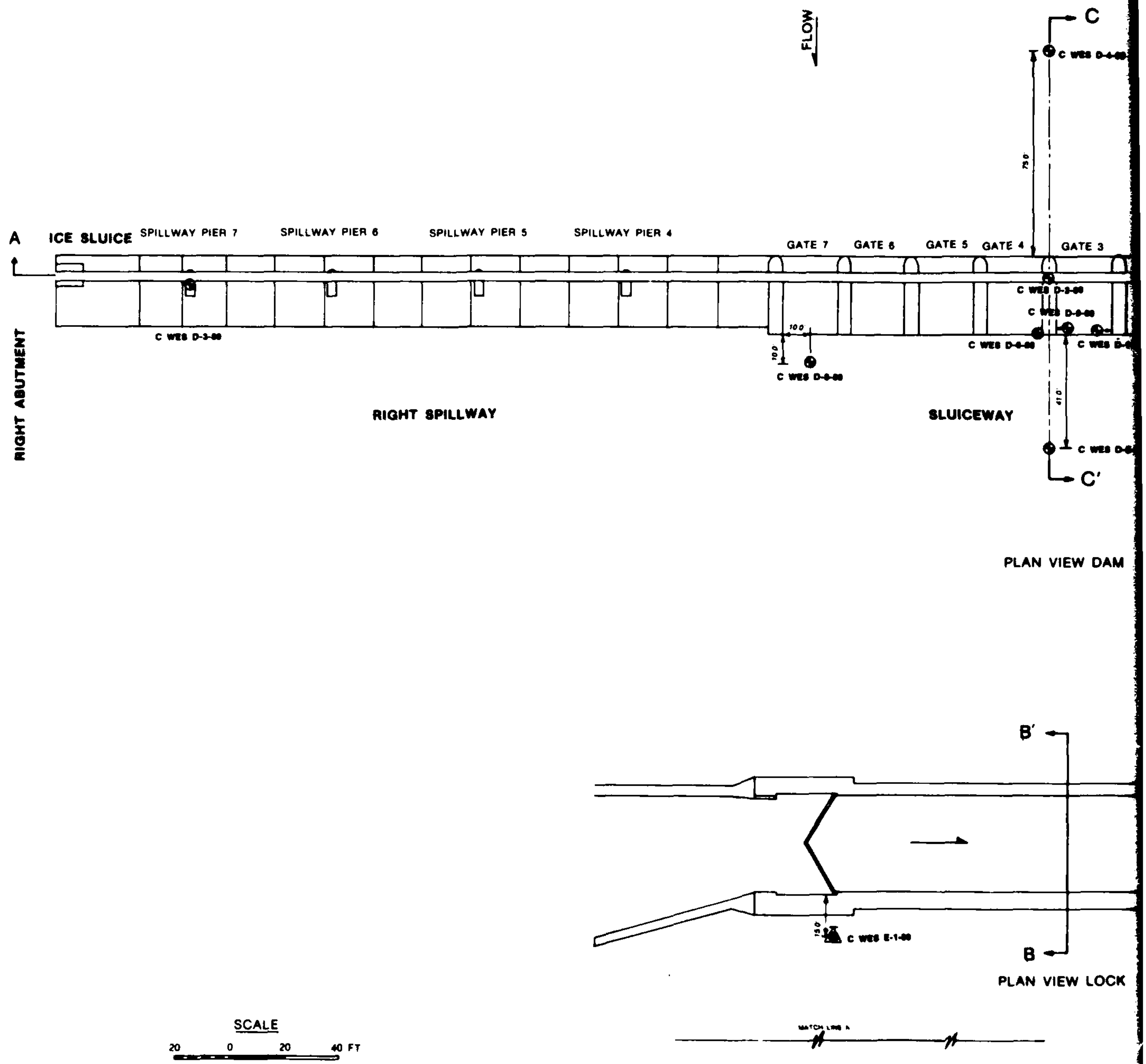

I-7
N
ION
GATE
ESS
PEERENBOOM CREEK
LITTLE CHUTE
NORTH AVE.
WASHINGTON ST.
PIERCE AVE
MC KINLEY ST
1836 TREATY OF THE CEDARS MONUMENT (HISTORICAL SITE)
ADAMS ST
ARTHUR ST
CLEVELAND ST
JEFFERSON
MAIN ST
C & N W RY
CIRCLE ACRES TRAILER PARK
AERIAL TRANS LINE
CEDARS LOCK
U S PROPERTY
PROJECT DEPTH 6
ROCKS
S L W EL 698 66
U S PROPERTY
RIVER
S. L. W. EL. 688 88
SPILLWAY 283
SLUICE WAY 180
SPILLWAY 211
U S DAM
KIMBERLY CLARK CORP
MILE 27
STANDARD LOW WATER AND ELEVATIONS ARE REFERRED TO MEAN WATER LEVEL AT FATHER POINT, QUEBEC I G L D (1955) (INTERNATIONAL GREAT LAKES DATUM)
PROJECT DEPTH IS REFERRED TO STANDARD LOW WATER
VILLAGE OF KIMBERLY WASTE TREATMENT FACILITY
CHARLES ST
PINE ST
WILSON ST
OAK ST
MAES ST
PROSPECT ST
KIMBERLY
JOHN
SIDNEY
MAIN
KIMBERLY AVE
ELM
MAPLE
BIRCH
WALNUT
PINE
CEDARS LOCK AND DAM
FOX RIVER
WISCONSIN
IN 1 SHEET
SHEET NO 1
SCALE OF FEET
500
CORPS OF ENGINEERS
CHICAGO, ILLINOIS

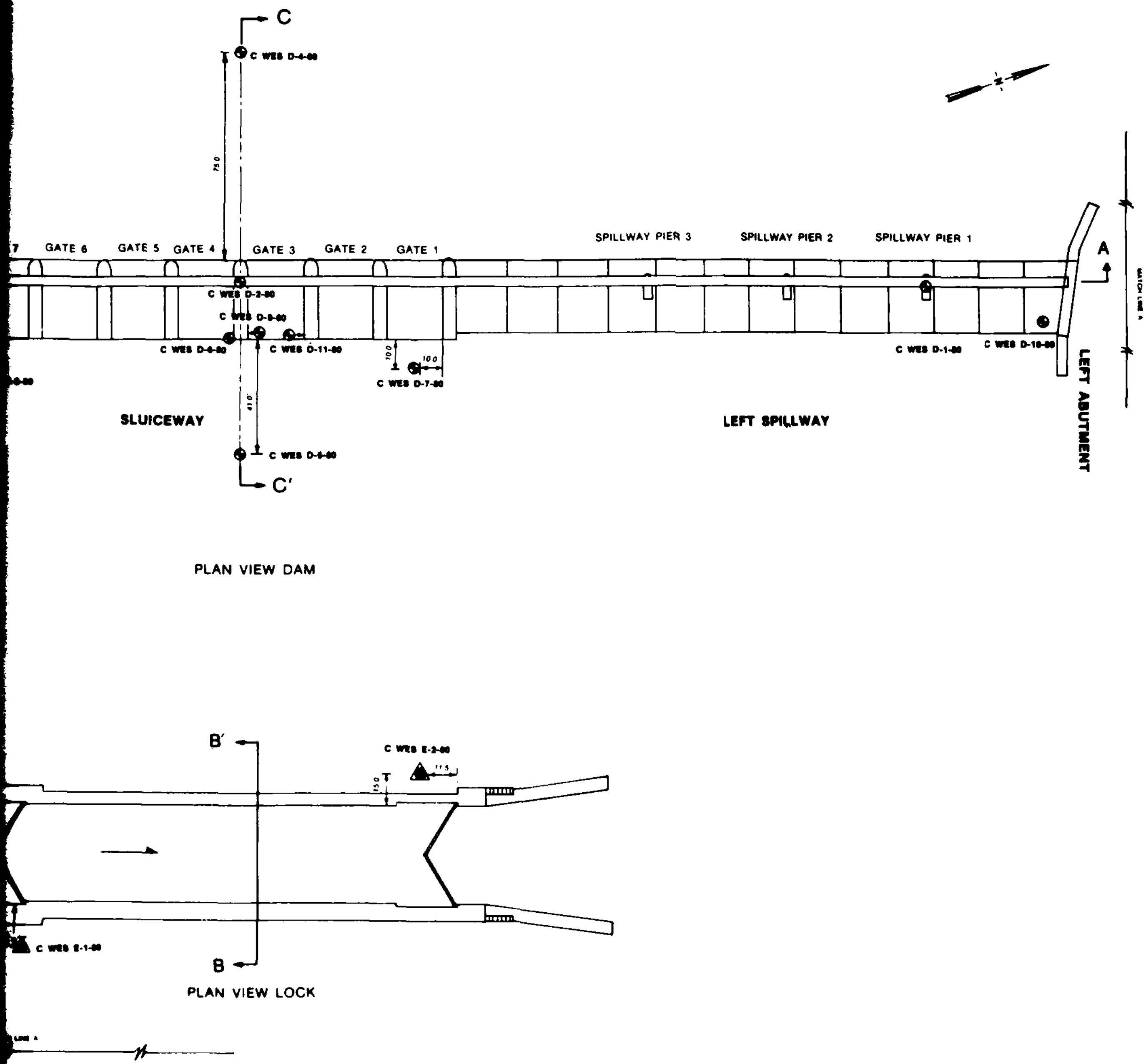
PLATE 1

1

2



BORING NUMBER	BORING LOCATION
C WES D-9-80	4 3' FROM TOP OF SLUICEWAY PIER 4 2 7' FROM D/S EDGE OF PIER
C WES D-10-80	D/S OF WALKWAY, CENTER OF CONCRETE LIFT, 1 0' BELOW TOP OF LIFT CONSTRUCTION JOINT
C WES D-11-80	3 9' FROM TOP OF SLUICEWAY PIER 3 1 5' FROM D/S EDGE OF PIER



CONDIT... ...VEY
AUGU... ...80
CEDARS LOCK AND DAM
BORING LOCATION PLAN &
GEOLOGIC CROSS SECTIONS

PLATE 2

1 2

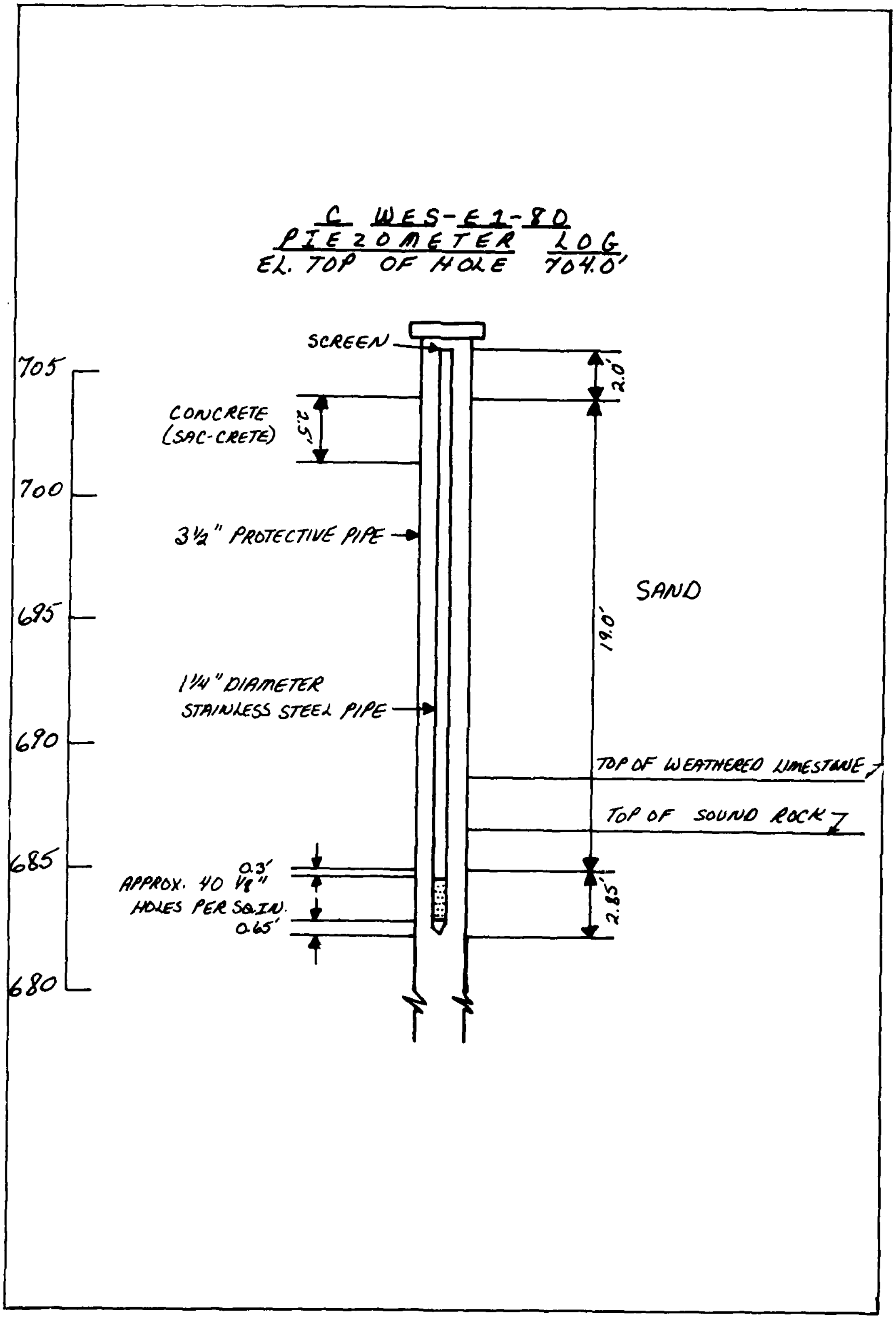
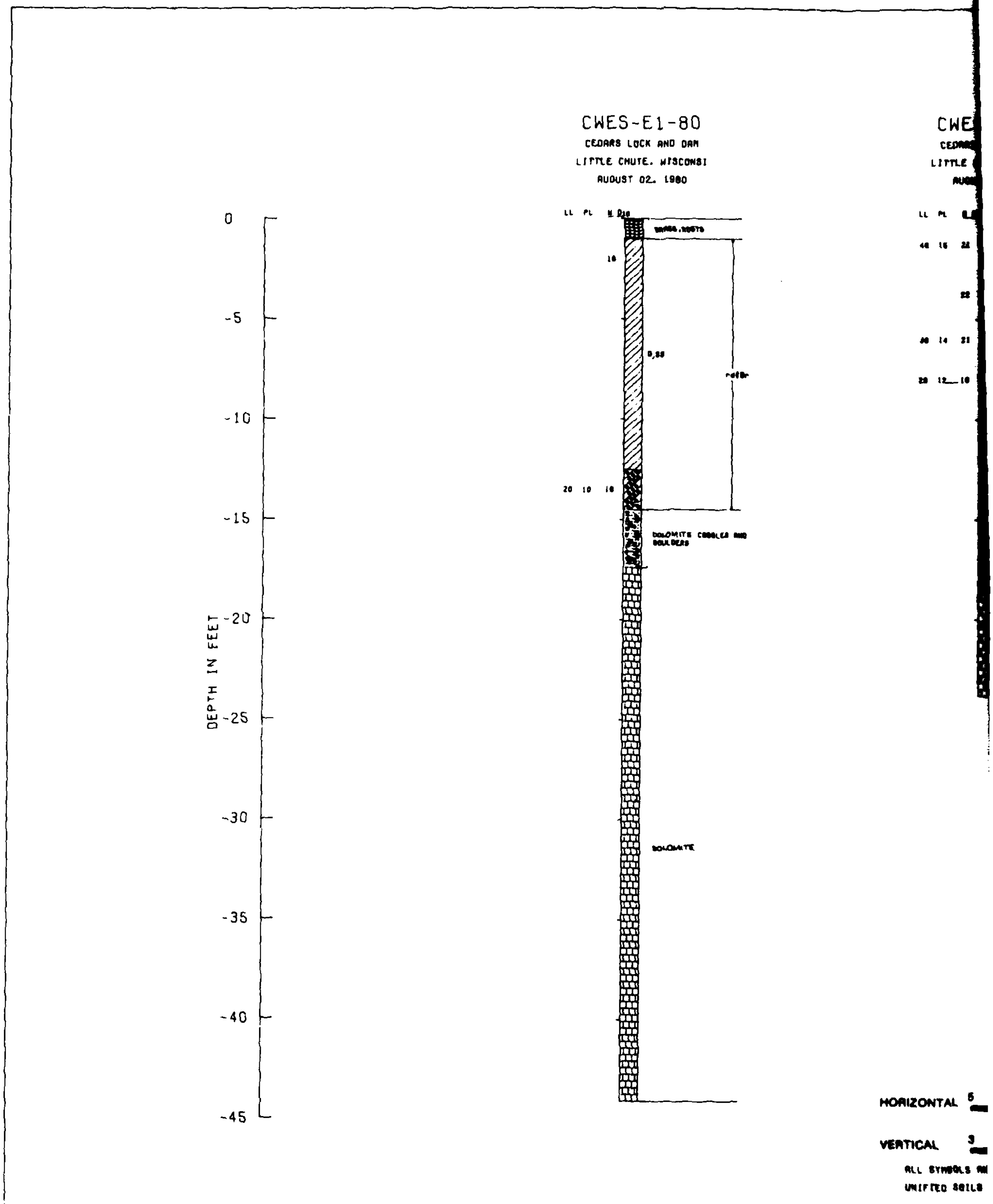
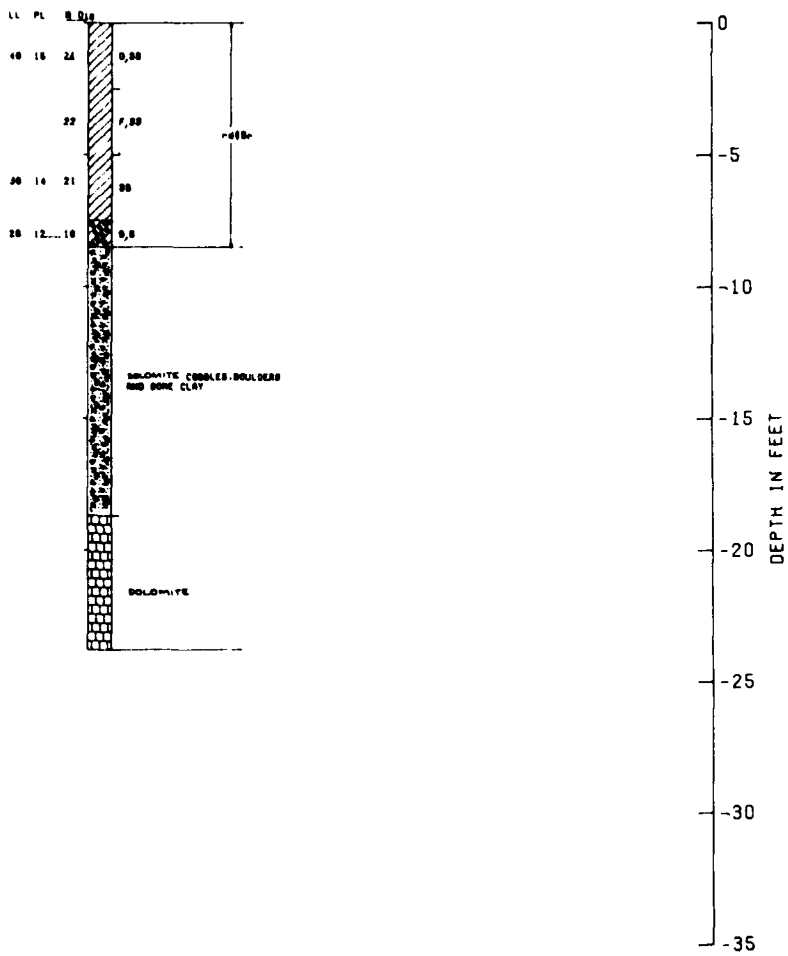

C WES-E1-80
PIEZOMETER LOG
EL. TOP OF HOLE 704.0'
SCREEN
705
700
695
690
685
680
CONCRETE
(SAC-CRETE)
2.5'
2.0'
3½" PROTECTIVE PIPE
SAND
19.0'
1¼" DIAMETER
STAINLESS STEEL PIPE
TOP OF WEATHERED LIMESTONE
TOP OF SOUND ROCK
0.3'
APPROX. 40 ⅛"
HOLES PER SQ.IN.
0.65'
2.85'

PLATE 3



CWES-E1-80
CEDARS LOCK AND DAM
LITTLE CHUTE. WISCONSI
AUGUST 02. 1980
LL PL W
DOLOMITE COBBLES AND BOULDERS
DOLOMITE
DEPTH IN FEET
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
HORIZONTAL
VERTICAL

CWES-E2-8C
CEDARS LOCK AND DAM
LITTLE CHUTE, WISCONSI
AUGUST 16, 1980



SCALES

HORIZONTAL 5 0 5 10 FT

VERTICAL 3 0 3 6 FT

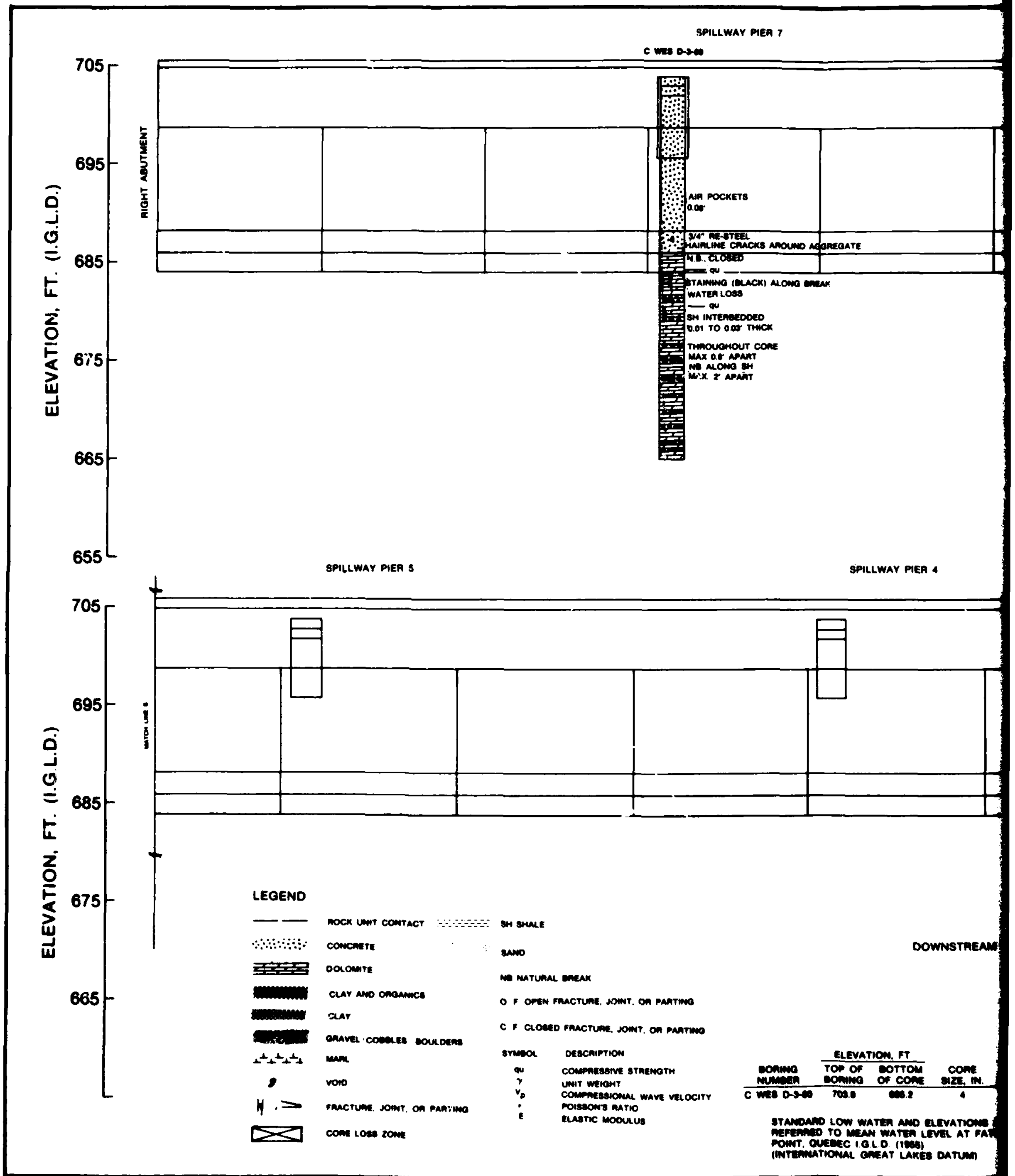
ALL SYMBOLS AND CHARACTERS CONFORM TO THE UNIFIED SOILS CLASSIFICATION SYSTEM

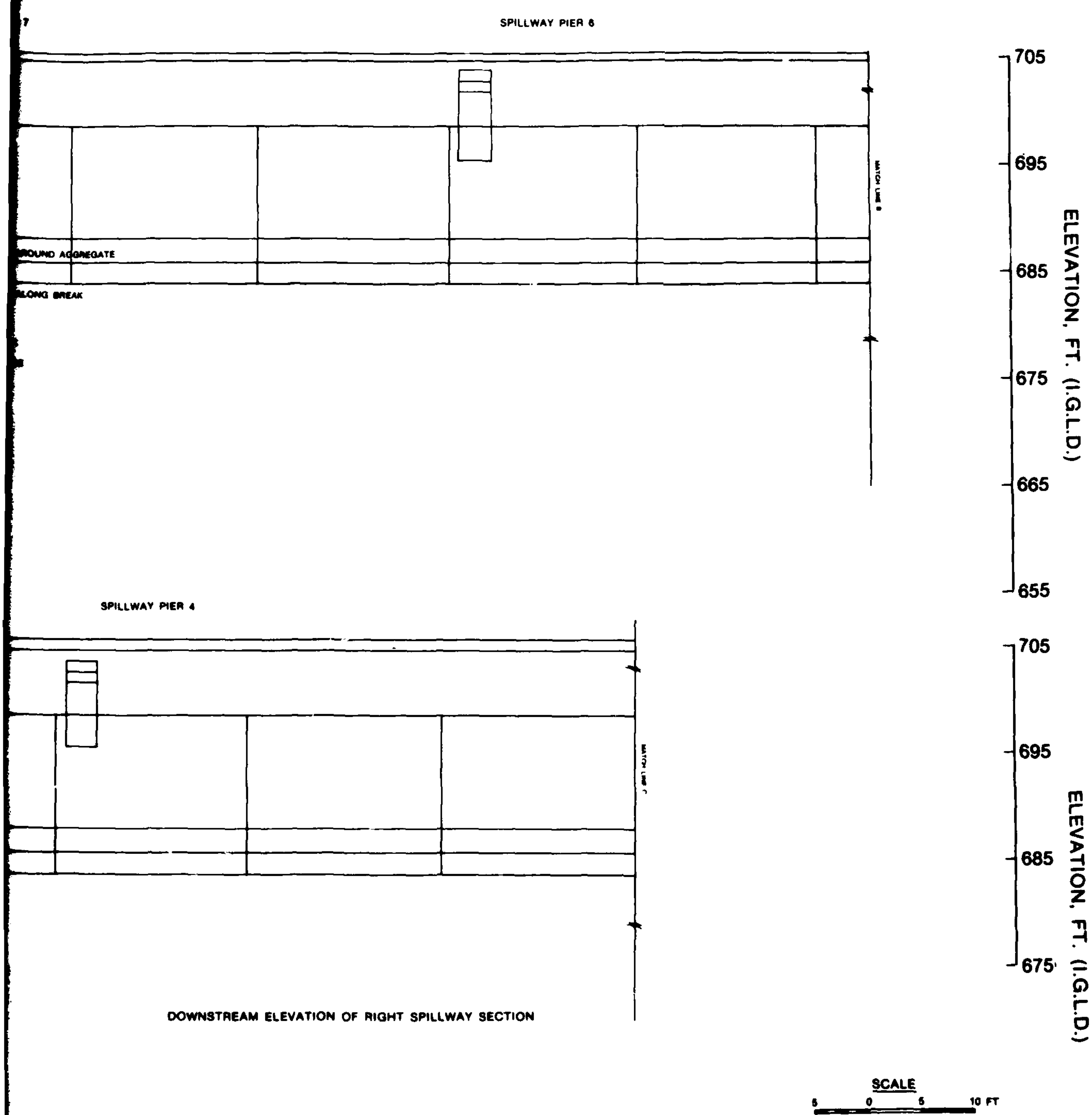
CEDARS LOCK AND DAM

PLATE 4

1

2


SPILLWAY PIER 7
C WES D-3-80
705
695
685
675
665
655
ELEVATION, FT. (I.G.L.D.)
RIGHT ABUTMENT
AIR POCKETS
0.08'
3/4" RE-STEEL
HAIRLINE CRACKS AROUND AGGREGATE
N.B. CLOSED
qu
STAINING (BLACK) ALONG BREAK
WATER LOSS
qu
SH INTERBEDDED
0.01 TO 0.03' THICK
THROUGHOUT CORE
MAX 0.8' APART
NB ALONG SH
MAX. 2' APART
SPILLWAY PIER 5
SPILLWAY PIER 4
705
695
685
675
665
ELEVATION, FT. (I.G.L.D.)
LEGEND
ROCK UNIT CONTACT
CONCRETE
DOLOMITE
CLAY AND ORGANICS
CLAY
GRAVEL COBBLES BOULDERS
MARL
VOID
FRACTURE, JOINT, OR PARTING
CORE LOSS ZONE
SH SHALE
SAND
NB NATURAL BREAK
O F OPEN FRACTURE, JOINT, OR PARTING
C F CLOSED FRACTURE, JOINT, OR PARTING
SYMBOL DESCRIPTION
qu COMPRESSIVE STRENGTH
γ UNIT WEIGHT
Vp COMPRESSIONAL WAVE VELOCITY
ν POISSON'S RATIO
E ELASTIC MODULUS
DOWNSTREAM
ELEVATION, FT
BORING NUMBER | TOP OF BORING | BOTTOM OF CORE | CORE SIZE, IN.
C WES D-3-80 | 703.8 | 665.2 | 4
STANDARD LOW WATER AND ELEVATIONS
REFERRED TO MEAN WATER LEVEL AT FAT
POINT, QUEBEC I.G.L.D. (1955)
(INTERNATIONAL GREAT LAKES DATUM)



BORING NUMBER	ELEVATION, FT TOP OF BORING	BOTTOM OF CORE	CORE SIZE, IN	CORE RECOVERY, %
D-3-80	703.8	685.2	4	98.0

STANDARD LOW WATER AND ELEVATIONS ARE REFERRED TO MEAN WATER LEVEL AT FATHER POINT, QUEBEC I G L D (1955) (INTERNATIONAL GREAT LAKES DATUM)

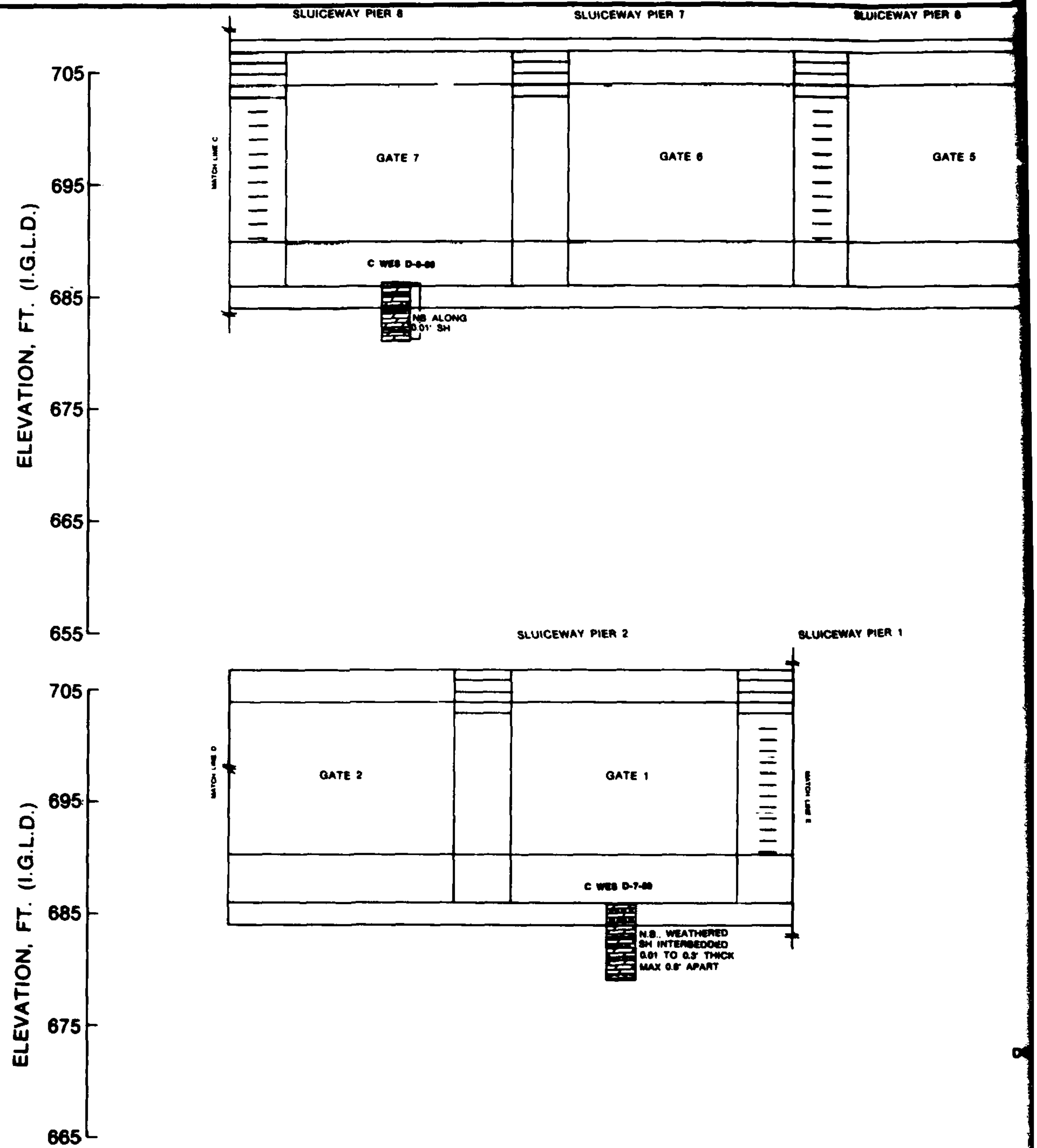
CONDITION SURVEY
AUGUST 1980
CEDARS LOCK AND DAM

GEOLOGIC CROSS SECTION

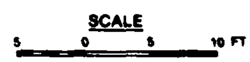
SECTION A-A'

PLATE 5

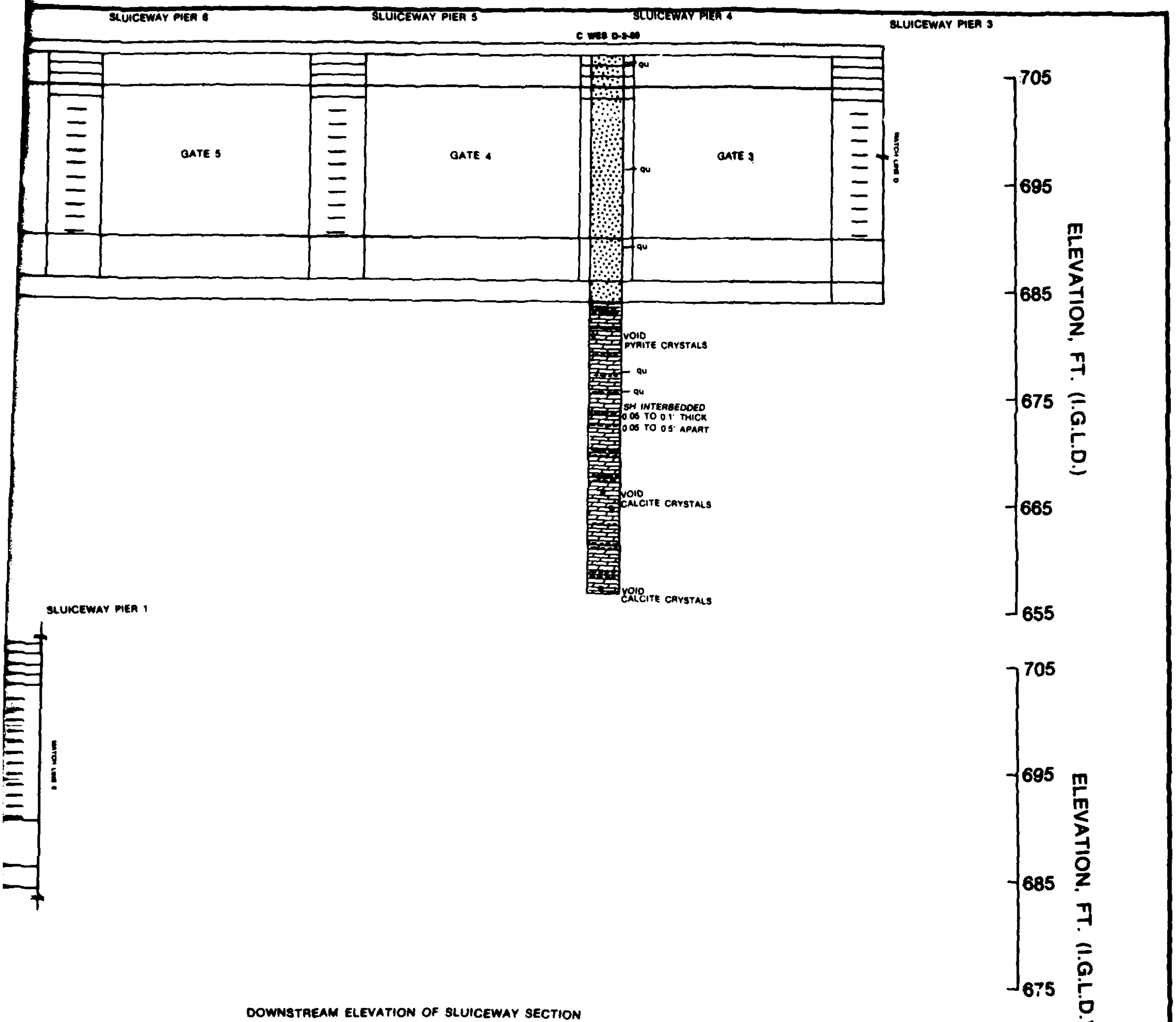
2



BORING NUMBER	ELEVATION, FT TOP OF BORING	ELEVATION, FT BOTTOM OF CORE	CORE SIZE, IN.	CORE RECOVERY, %
C WES D-2-80	706.97	656.97	4	100
C WES D-7-80	690.01	679.88	4	100
C WES D-8-80	690.01	681.86	4	87.5



1



DOWNSTREAM ELEVATION OF SLUICEWAY SECTION

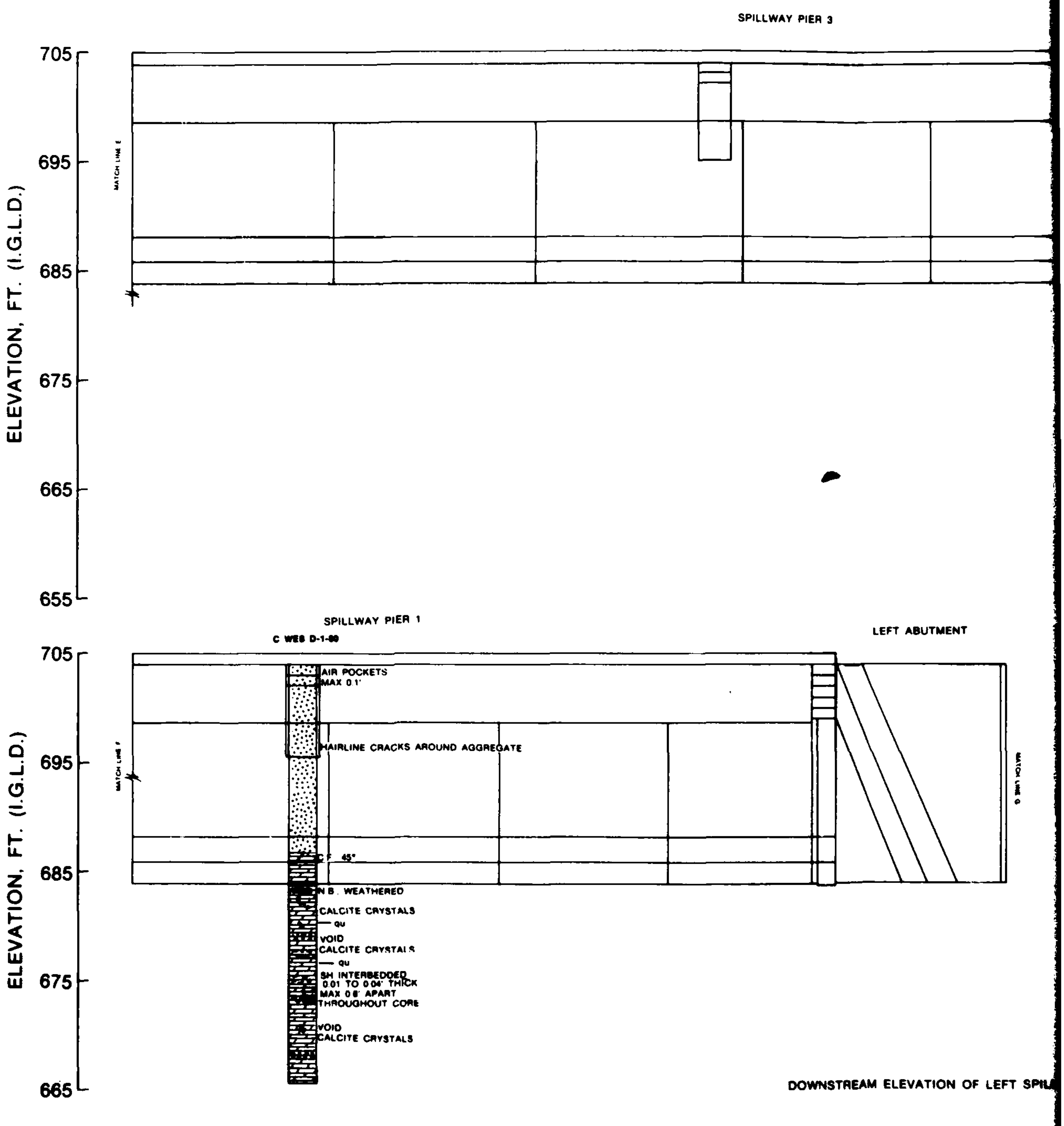
CONDITION SURVEY
AUGUST 1980
CEDARS LOCK AND DAM

GEOLOGIC CROSS SECTION

SECTION A-A'

PLATE 6

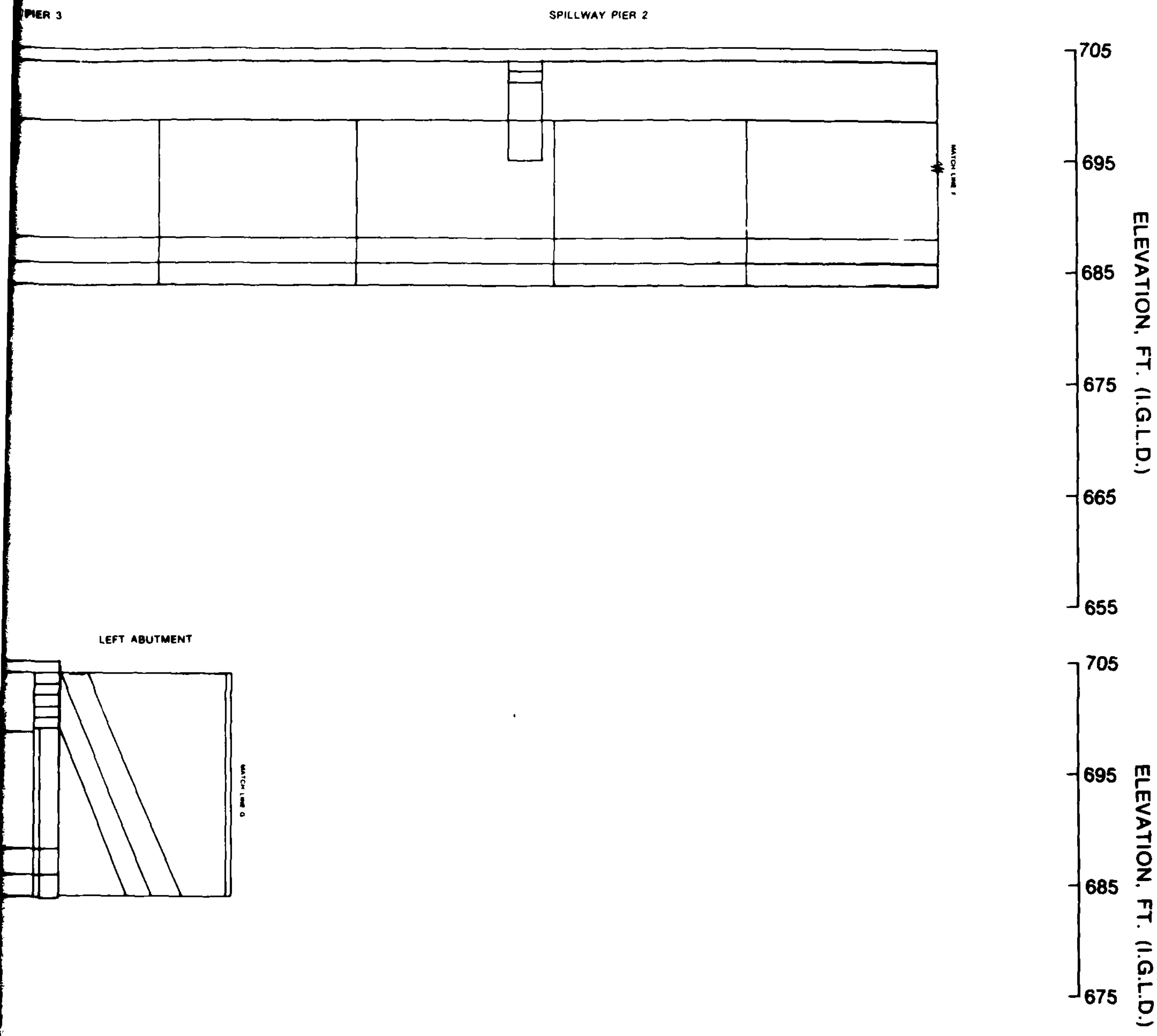
2



DOWNSTREAM ELEVATION OF LEFT SPIL

BORING NUMBER	ELEVATION, FT TOP OF BORING	ELEVATION, FT BOTTOM OF CORE	CORE SIZE, IN	CORE RECOVERY, %
C WES D-1-80	703.8	666.5	4	99.3

SCALE
5 0 5



DOWNSTREAM ELEVATION OF LEFT SPILLWAY SECTION

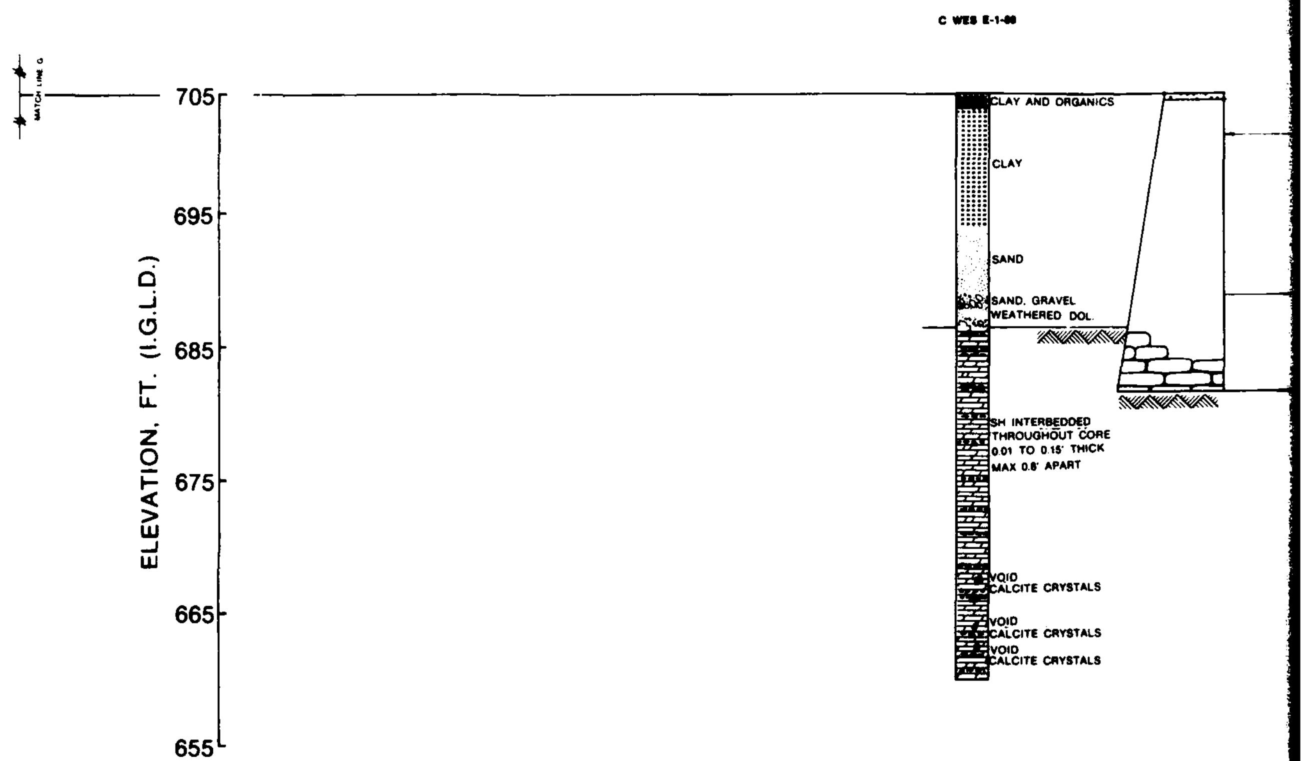
SCALE
5 0 5 10 FT

CONDITION SURVEY
AUGUST 1980
CEDARS LOCK AND DAM

GEOLOGIC CROSS SECTION

SECTION A-A'

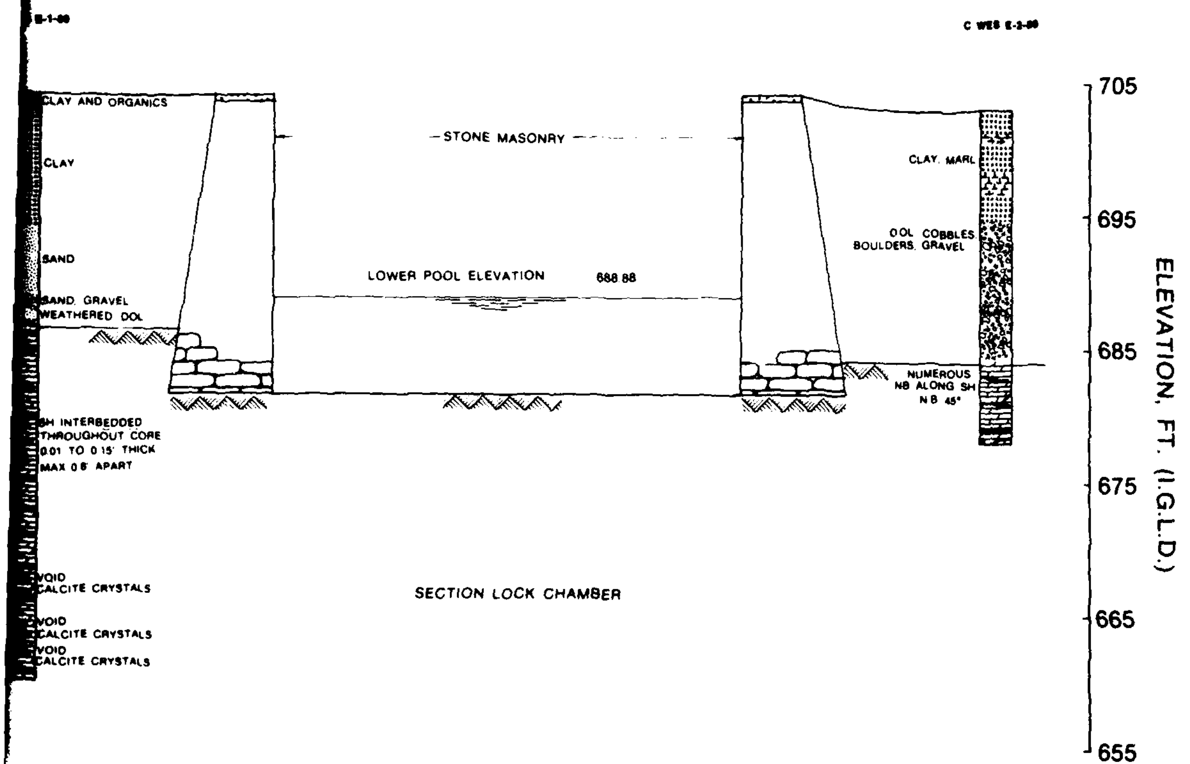
PLATE 7



SCALE

5 0 5 10 FT

BORING NUMBER	ELEVATION, FT TOP OF BORING	ELEVATION, FT BOTTOM OF CORE	CORE SIZE, IN	CORE RECOVERY, %
C WES E-1-80	704.0	659.9	4	100
C WES E-2-80	702.8	679.0	NX	100

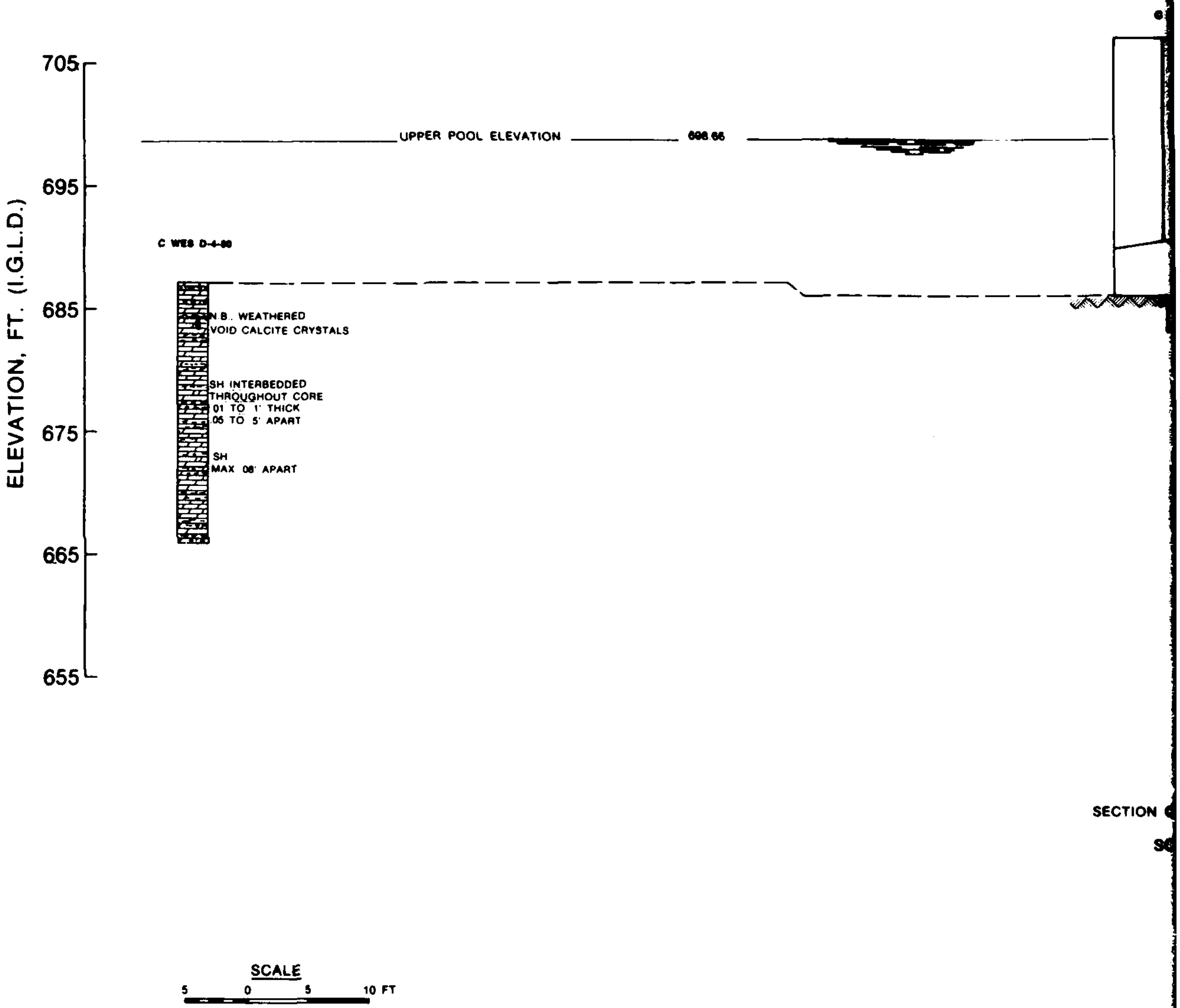


CONDITION SURVEY
AUGUST 1980
CEDARS LOCK AND DAM

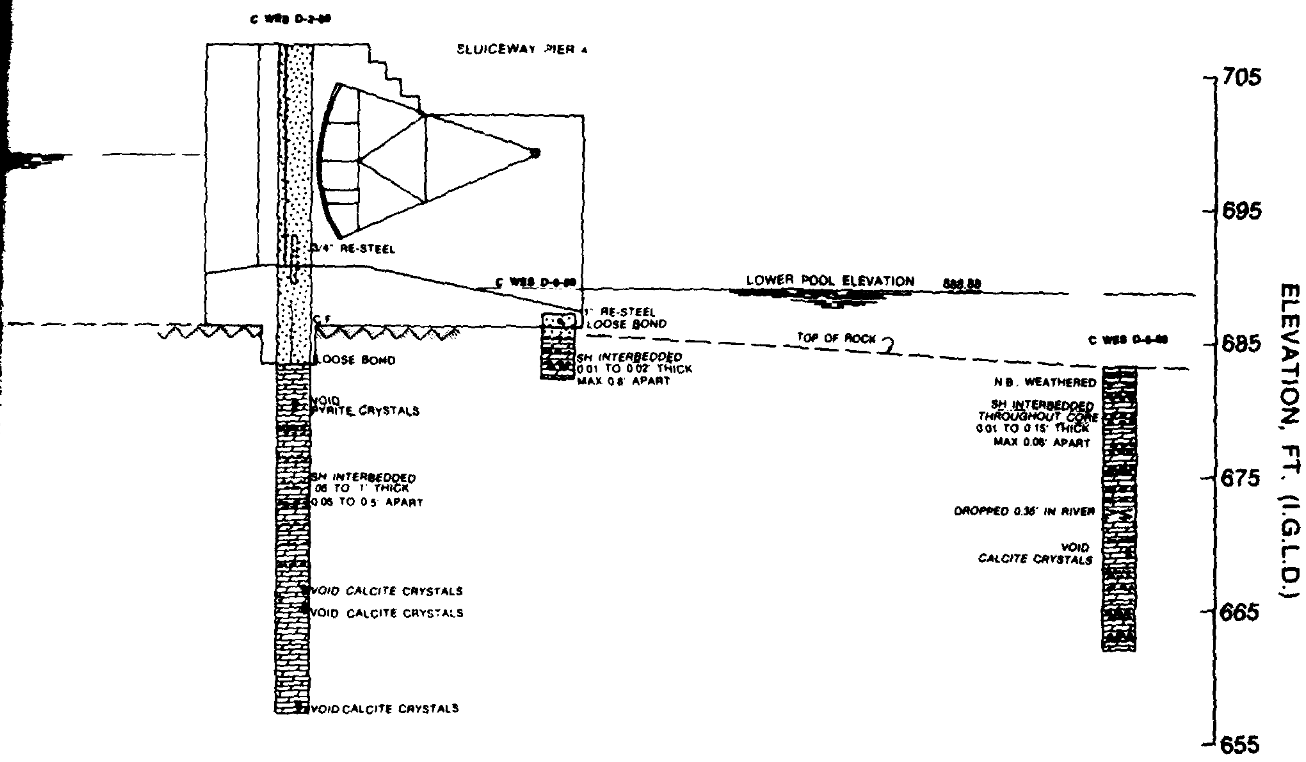
GEOLOGIC CROSS SECTION

SECTION B-B'

PLATE 8



	ELEVATION, FT			
BORING NUMBER	TOP OF BORING	BOTTOM OF CORE	CORE SIZE, IN.	CORE RECOVERY, %
C WES D-2-80	706 97	656.97	4	100
C WES D-4-80	687 1	665.9	4	98
C WES D-5-80	691.41	662.21	4	100
C WES D-6-80	689 91	662 11	4	100



SECTION OF TAINTER GATE PIER

SCALE 1" = 5'

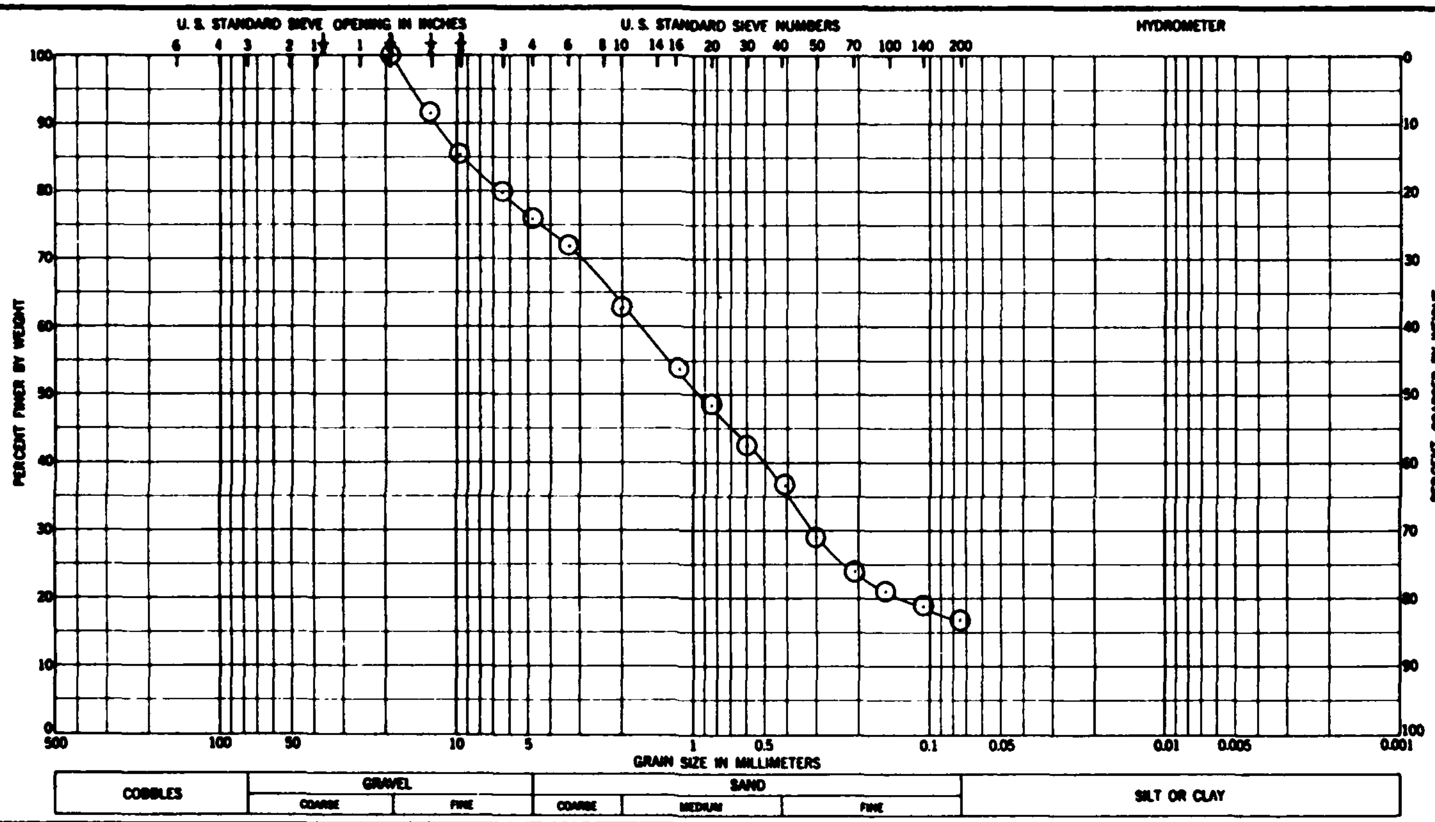
CONDITION SURVEY
AUGUST 1980
CEDARS LOCK AND DAM

GEOLOGIC CROSS SECTION

SECTION C-C'

PLATE 9

2



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
7	12.5-14.5	GRAVELLY CLAYEY SAND (SC)	15.7	20	10	10
		REDDISH BROWN				
		INSUFFICIENT SAMPLE FOR ACCURATE GRADATION				

Project CEDERS LOCK & DAM

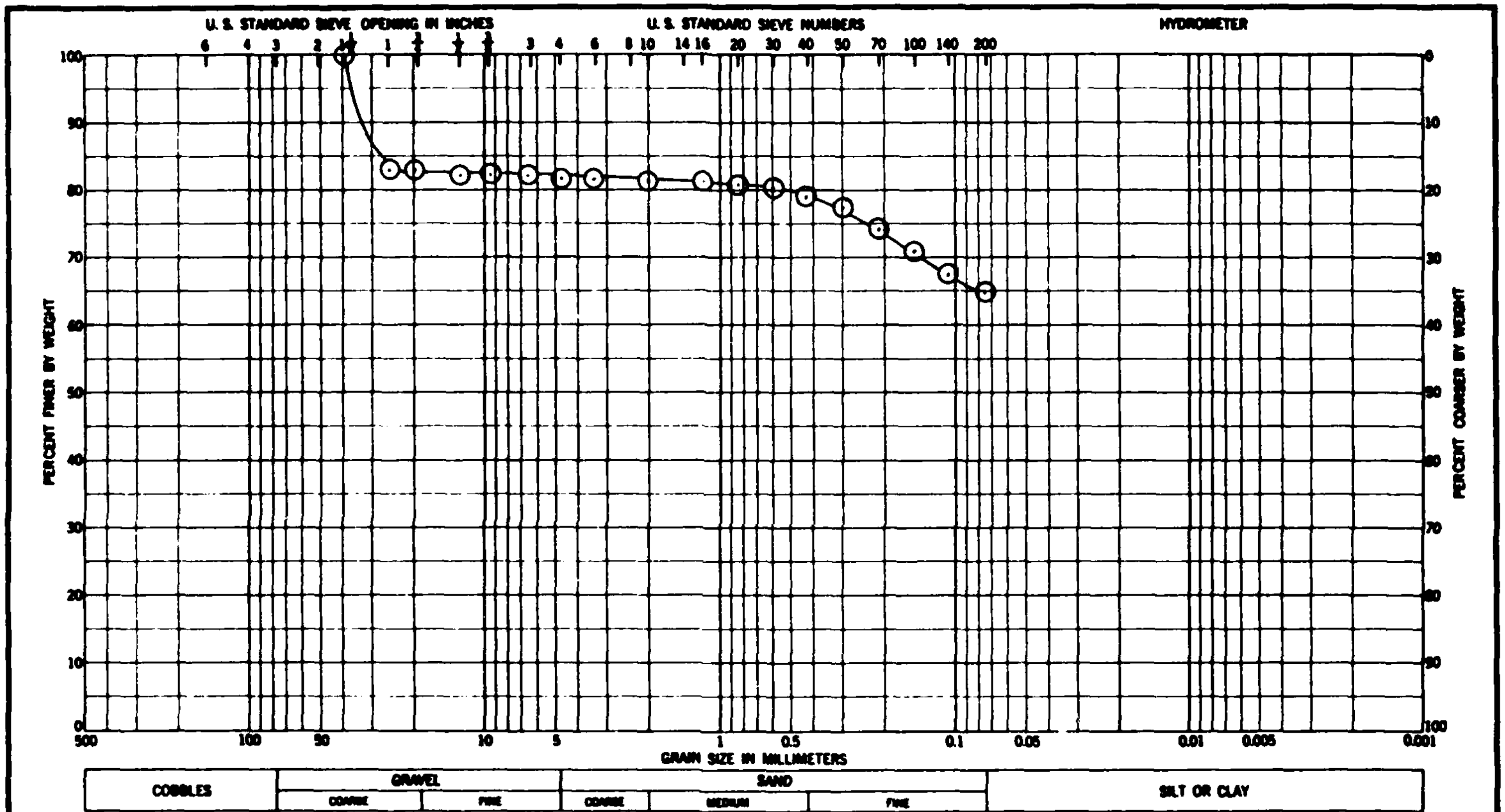
Area

Boring No. E-1

Date 23 MARCH, 1981

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1A	2.4-2.5	GRAVELLY SANDY CLAY (CL)	20.8	46	15	31
		REDDISH BROWN				
		INSUFFICIENT SAMPLE FOR ACCURATE GRADATION				

GRADATION CURVES

Project CEDERS LOCK & DAM

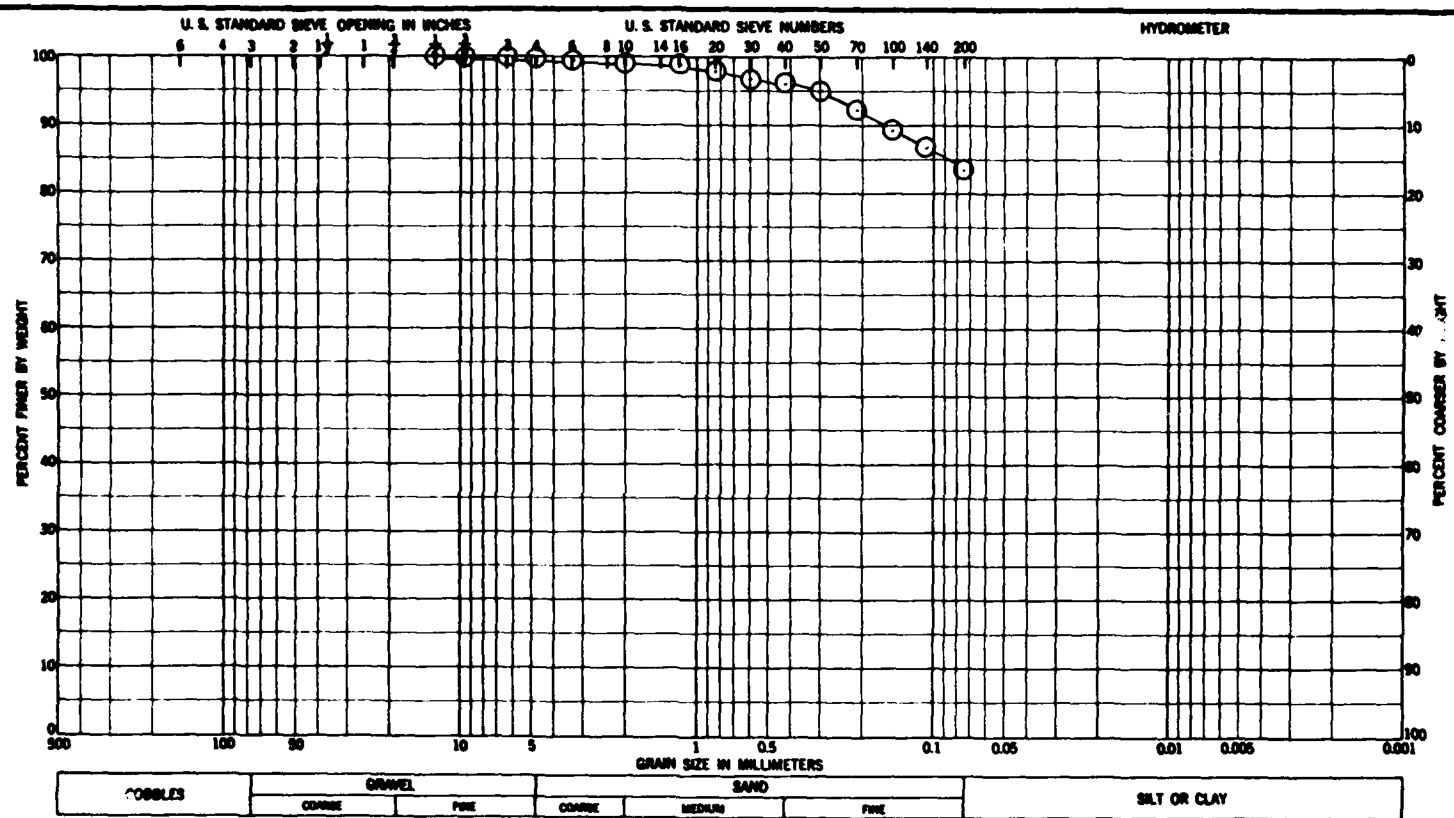
Area

Boring No. E-2

Date 23 MARCH, 1981

ENG FORM 1 MAY 63 2087

PLATE 11



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3A	5.8-6.1	SANDY CLAY (CL). REDDISH BROWN	20.6	36	14	22

Project CEDERS LOCK & DAM

Area

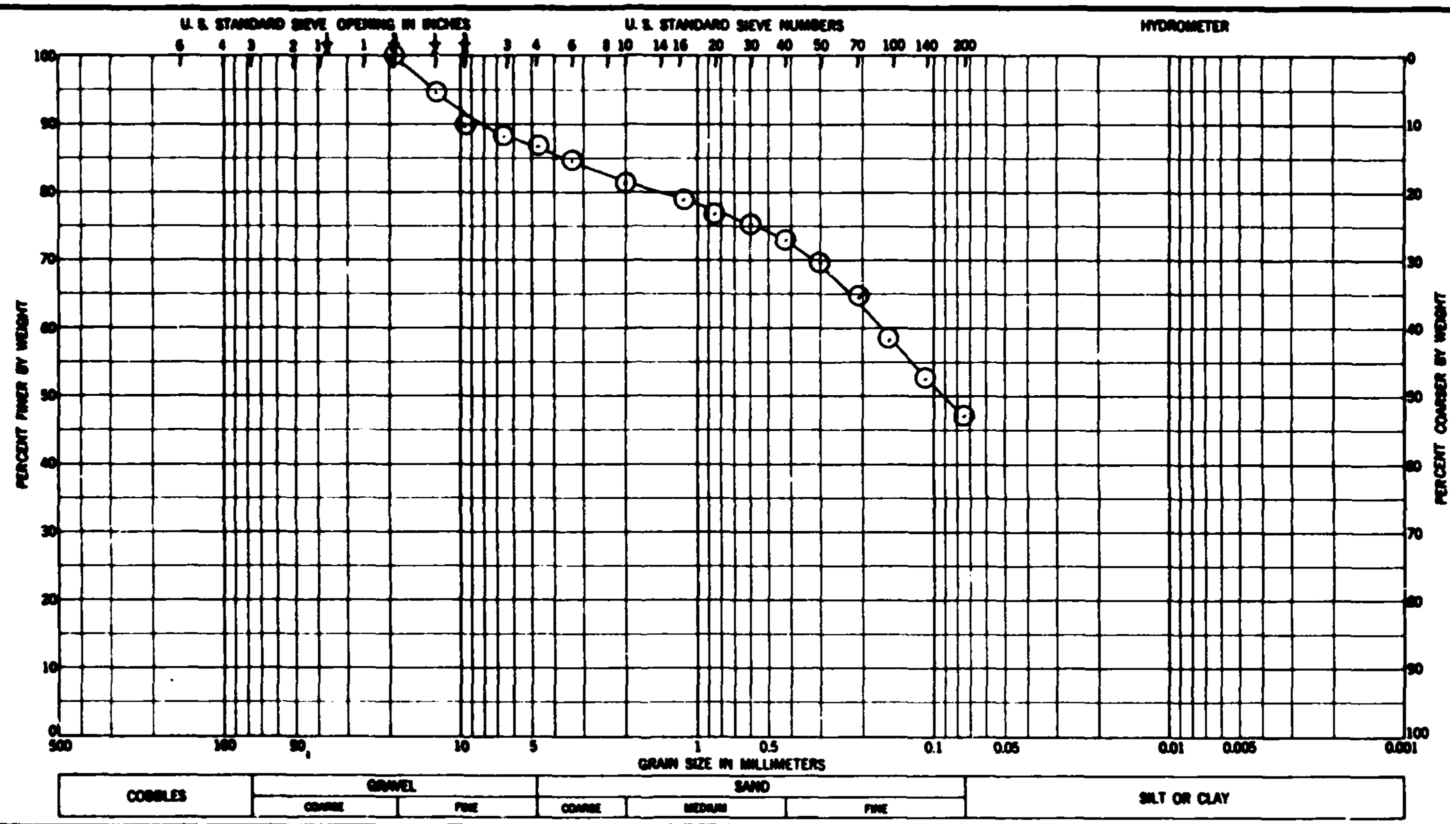
Boring No. E2

Date 23 MARCH, 1981

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE 12



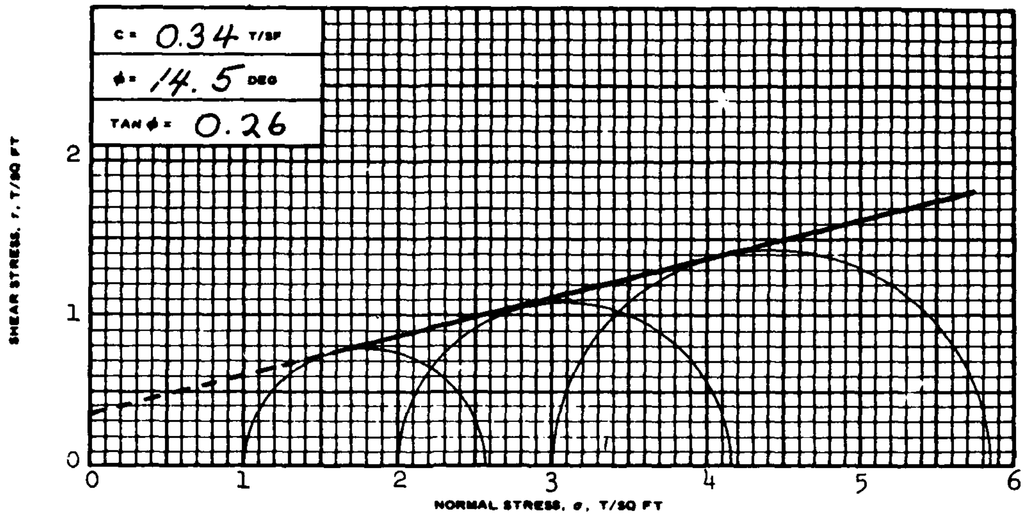
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4A	7.0-7.55	GRAVELLY CLAYEY SAND (SC)	15.7	28	12	16
		REDDISH BROWN				
		INSUFFICIENT SAMPLE FOR ACCURATE GRADATION				

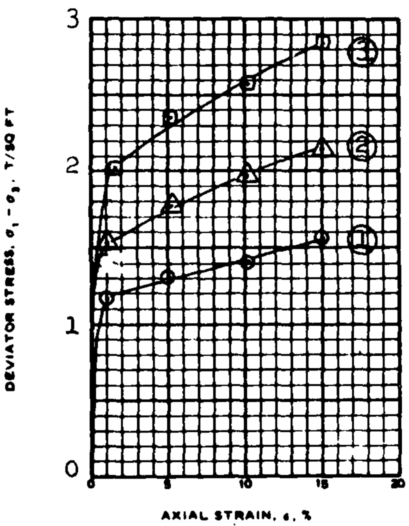
Project	CEDERS LOCK & DAM
Area	
Boring No.	E2
Date	23 MARCH, 1981

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE 13





SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	17.0	15.9	15.8
	DRY DENSITY LB/CU FT	γ_{d_o}	104.2	106.2	105.8
	SATURATION, %	S_o	73.5	72.2	71.1
	VOID RATIO	e_o	0.630	0.599	0.604
BEFORE SHEAR	WATER CONTENT, %	w_c	21.4	19.8	19.1
	DRY DENSITY LB/CU FT	γ_{d_c}	106.3	110.5	112.7
	SATURATION, %	S_c	97.4	100+	100+
	VOID RATIO	e_c	0.598	0.537	0.506
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.04	5.04	5.04
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.0	2.0	3.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.56	2.16	2.84
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1071	1071	1071
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$			
INITIAL DIAMETER, IN.		D_o	1.42	1.40	1.42
INITIAL HEIGHT, IN.		H_o	3.00	3.00	3.00

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS CLAY (CL), REDDISH BROWN; COARSE SAND

LL | PL | PI | G_s | TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST $\overline{R}$

REMARKS:

PROJECT CEDARS LOCK & DAM

BORING NO. E-1 | SAMPLE NO. 1-C

DEPTH/ELEV

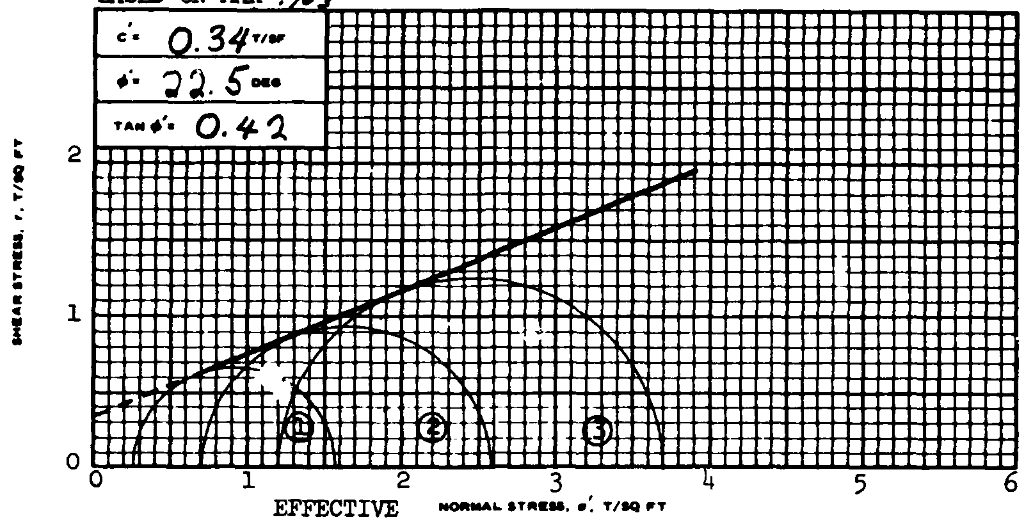
LABORATORY USAEWES | DATE 24 JAN 81

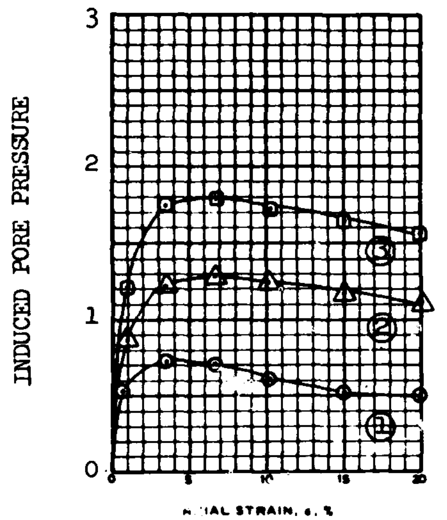
SHEET 1 OF 2 | JMS | TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

BASED ON MAX σ_1'/σ_3'

c' =	0.34 T/SF
ϕ' =	22.5 DEG
TAN ϕ' =	0.42





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o				
	DRY DENSITY LB/CU FT	γd_o				
	SATURATION, %	S_o				
	VOID RATIO	e_o				
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.27	0.71	1.20	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.31	1.86	2.49	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f				
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$				
INITIAL DIAMETER, IN.		D_o				
INITIAL HEIGHT, IN.		H_o				

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS

LL	PL	PI	Gs	TYPE OF SPECIMEN	TYPE OF TEST

REMARKS:

PROJECT CEDARS LOCK & DAM

BORING NO. E-1 SAMPLE NO. 1-C

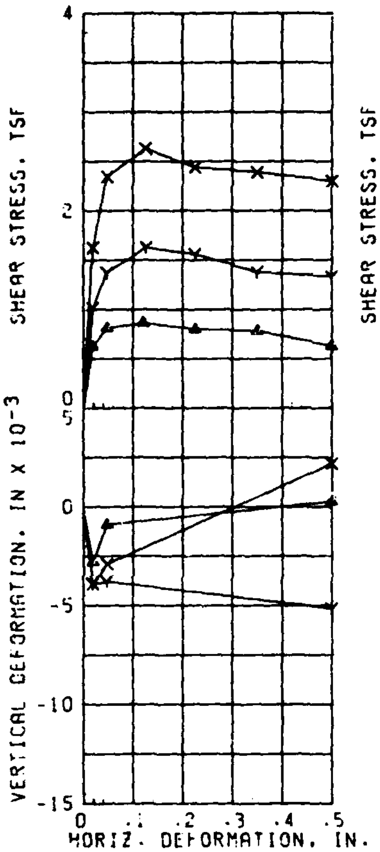
DEPTH/ELEV

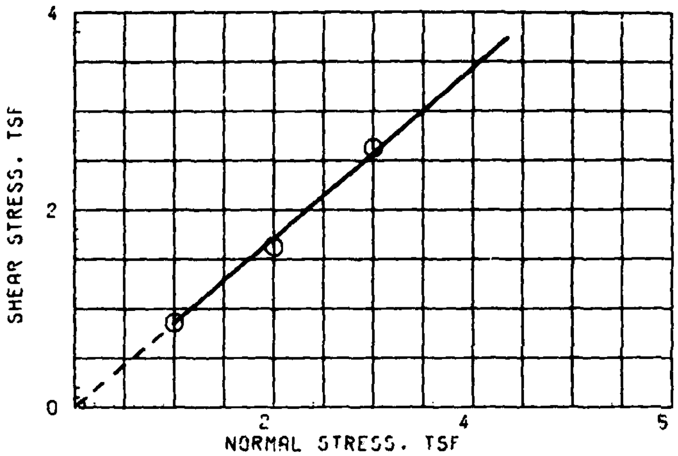
LABORATORY USAEWES DATE 24 JAN 81

SHEET 2 OF 2

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)





ϕ = 40.5°

TAN ϕ = 0.86

C = 0

	TEST NO.	1 ▲	2 Y	3 X
INITAL	WATER CONTENT, %	10.5	10.6	9.9
	VOID RATIO	0.189	0.175	0.176
	SATURATION, %	100 +	100 +	100 +
	DRY DENSITY, PCF	141.1	142.8	142.7
	VOID RATIO AFTER CONSOL			
	FIFTY PERCENT CONSOL, MIN	< 1	< 1	< 1
FINAL	WATER CONTENT, %	10.9	10.4	10.1
	VOID RATIO			
	SATURATION, %			
	NORMAL STRESS, TSF	1.0	2.0	3.0
	MAXIMUM SHEAR STRESS, TSF	0.86	1.62	2.63
	TIME TO FAILURE, MIN	564	594	594
	RATE OF STRAIN, IN/MIN	.00019	.00019	.00018
	ULTIMATE SHEAR STRESS, TSF			

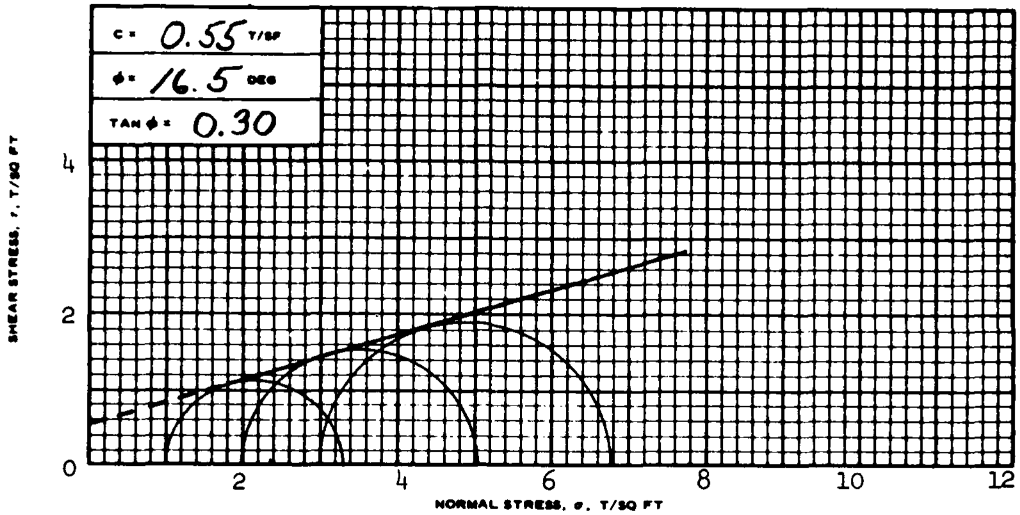
TYPE SPECIMEN UNDISTURBED	3.00 IN. SQUARE	0.594 IN. THICK

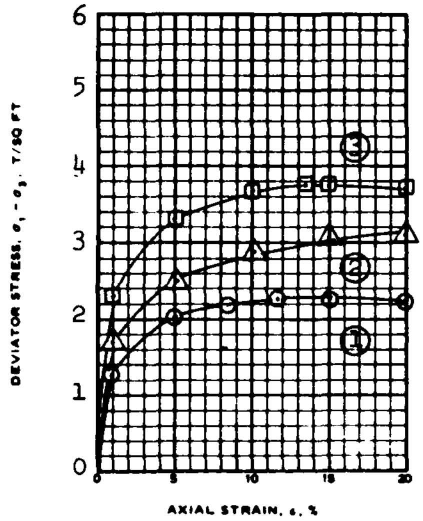
CLASSIFICATION GRAVELLY SANDY CLAY (CL), BROWNISH RED

LL	PL	PI		GS 2.69 (EST)

REMARKS.	PROJECT CEDARS LOCK & DAM	
	BORING NO. E-1	SAMPLE 6-A
	DEPTH/ELEV -	DATE 20 MAR 81

DIRECT SHEAR TEST REPORT





SPECIMEN NO.		1	2	3
INITIAL: WATER CONTENT, %	w_o	20.4	23.0	22.2
INITIAL: DRY DENSITY LB/CU FT	γ_{d_o}	105.2	100.6	101.7
INITIAL: SATURATION, %	S_o	90.3	90.9	90.2
INITIAL: VOID RATIO	e_o	0.615	0.688	0.669
BEFORE SHEAR: WATER CONTENT, %	w_c	21.2	23.3	21.5
BEFORE SHEAR: DRY DENSITY LB/CU FT	γ_{d_c}	107.7	105.7	107.4
BEFORE SHEAR: SATURATION, %	S_c	100	100+	100+
BEFORE SHEAR: VOID RATIO	e_c	0.577	0.607	0.582
BEFORE SHEAR: FINAL BACK PRESSURE, T/SQ FT	u_o	5.04	5.04	5.04
MINOR PRINCIPAL STRESS, T/SQ FT	σ_3	1.0	2.0	3.0
MAXIMUM DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{max}$	2.28	3.04	3.77
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN	t_1	836	1071	964
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{ult}$			
INITIAL DIAMETER, IN.	D_o	1.41	1.41	1.42
INITIAL HEIGHT, IN.	H_o	3.00	3.00	3.00

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS: SANDY CLAY (CL), REDDISH BROWN; FINE SAND

LL	PL	PI	Gs	TYPE OF SPECIMEN: UNDISTURBED	TYPE OF TEST: R

REMARKS:

PROJECT: CEDARS LOCK & DAM

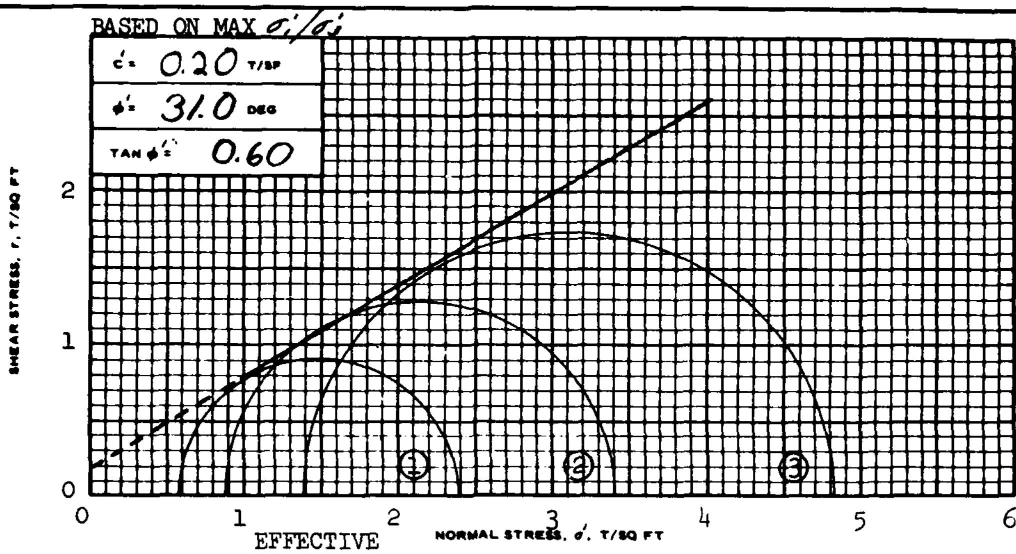
BORING NO. E-2 | SAMPLE NO. 2

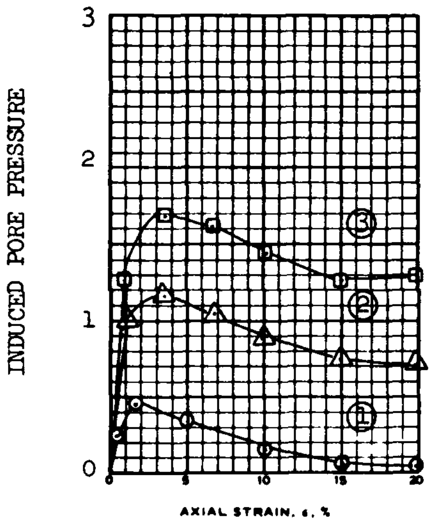
DEPTH/ELEV

LABORATORY: USAEWES | DATE: 26 JAN 81

SHEET 1 OF 2 | JMS | TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089, REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — *(EM 1110-2-1906)*





			1	2	3	
SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o				
	DRY DENSITY LB/CU FT	γd_o				
	SATURATION, %	S_o				
	VOID RATIO	e_o				
BEFORE SHEAR	WATER CONTENT, %	w_c				
	DRY DENSITY LB/CU FT	γd_c				
	SATURATION, %	S_c				
	VOID RATIO	e_c				
	FINAL BACK PRESSURE, T/SQ FT	u_o				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.57	0.88	1.39	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.82	2.54	3.43	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f				
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o				
INITIAL HEIGHT, IN.		H_o				

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS

LL	PL	PI	Gs	TYPE OF SPECIMEN	TYPE OF TEST
REMARKS:				PROJECT CEDARS LOCK & DAM	
				BORING NO. E-2	SAMPLE NO. 2
				DEPTH/ELEV	
				LABORATORY USAEWES	DATE 26 JAN 81
SHEET 2 OF 2				JMS TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

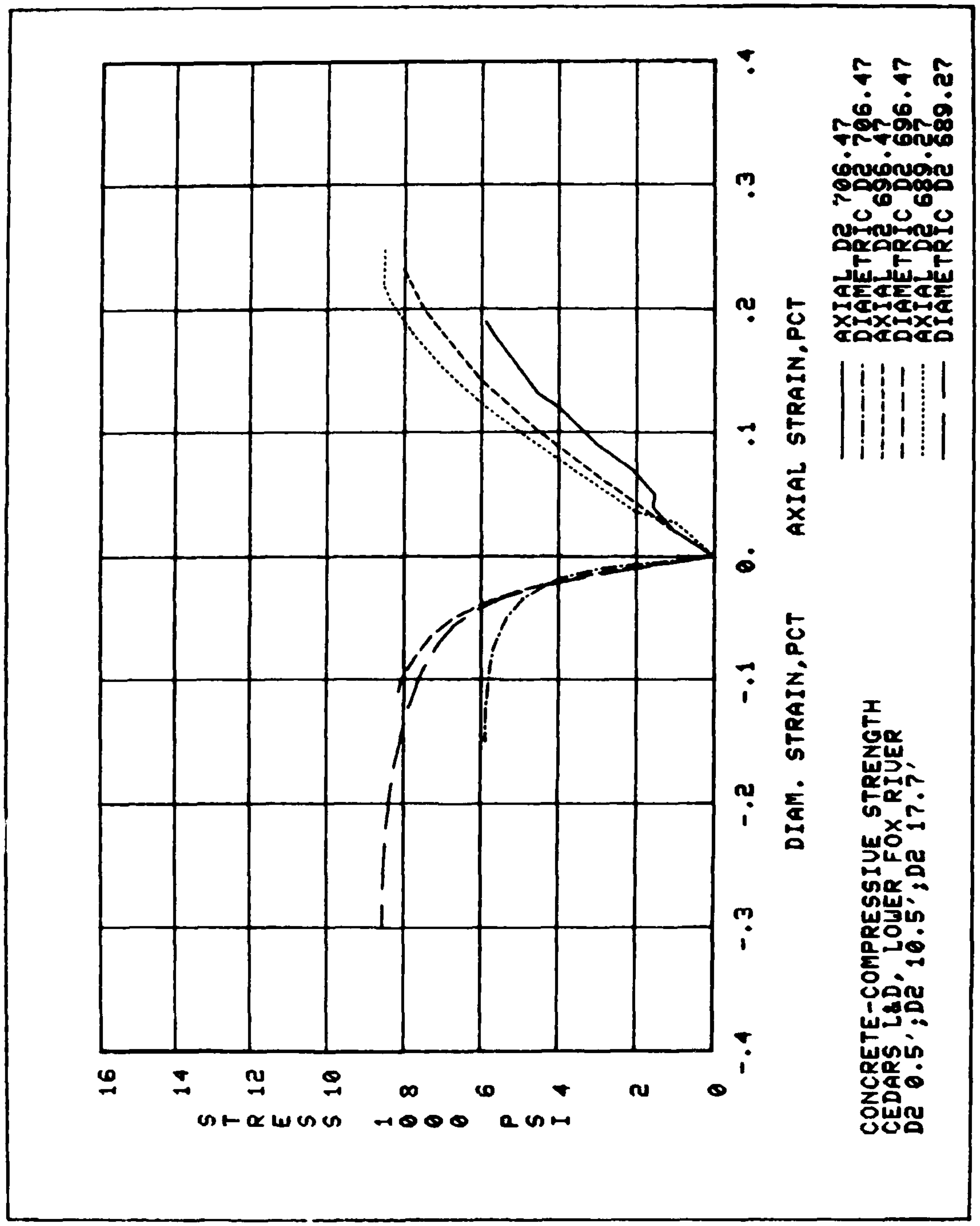

STRESS 1000 PSI
16
14
12
10
8
6
4
2
0
-.4
-.3
-.2
-.1
0.
.1
.2
.3
.4
DIAM. STRENGTH,PCT
AXIAL STRAIN,PCT
CONCRETE-COMPRESSIVE STRENGTH
CEDARS L&D, LOWER FOX RIVER
D2 0.5';D2 10.5';D2 17.7'
AXIAL D2 706.47
DIAMETRIC D2 706.47
AXIAL D2 696.47
DIAMETRIC D2 696.47
AXIAL D2 689.27
DIAMETRIC D2 689.27

PLATE 19

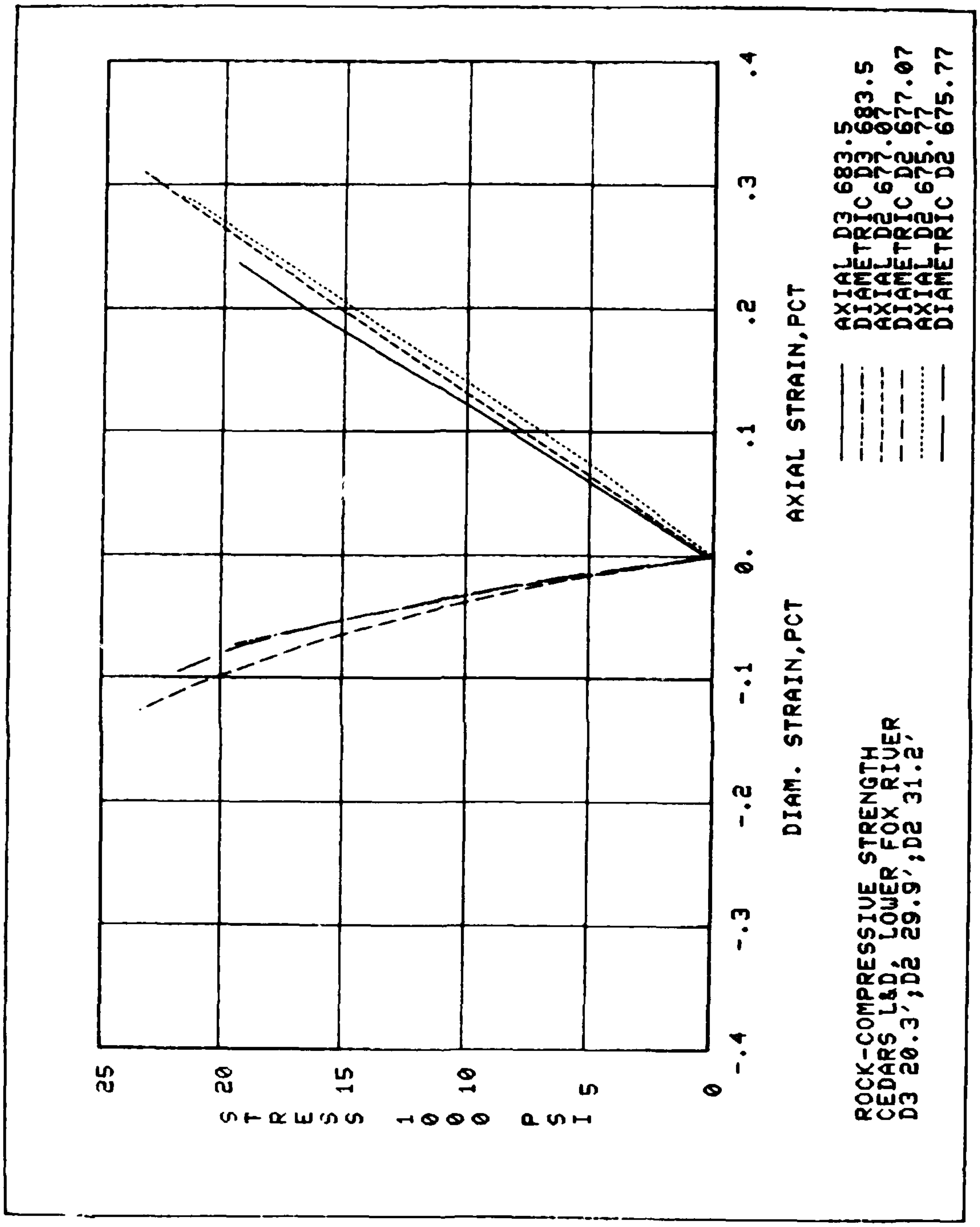

ROCK-COMPRESSIVE STRENGTH
CEDARS L&D, LOWER FOX RIVER
D3 20.3';D2 29.9';D2 31.2'
STRESS 1000 PSI
25
20
15
10
5
0
-.4
-.3
-.2
-.1
0.
.1
.2
.3
.4
DIAM. STRAIN,PCT
AXIAL STRAIN,PCT
AXIAL D3 683.5
DIAMETRIC D3 683.5
AXIAL D2 677.07
DIAMETRIC D2 677.07
AXIAL D2 675.77
DIAMETRIC D2 675.77

PLATE 20

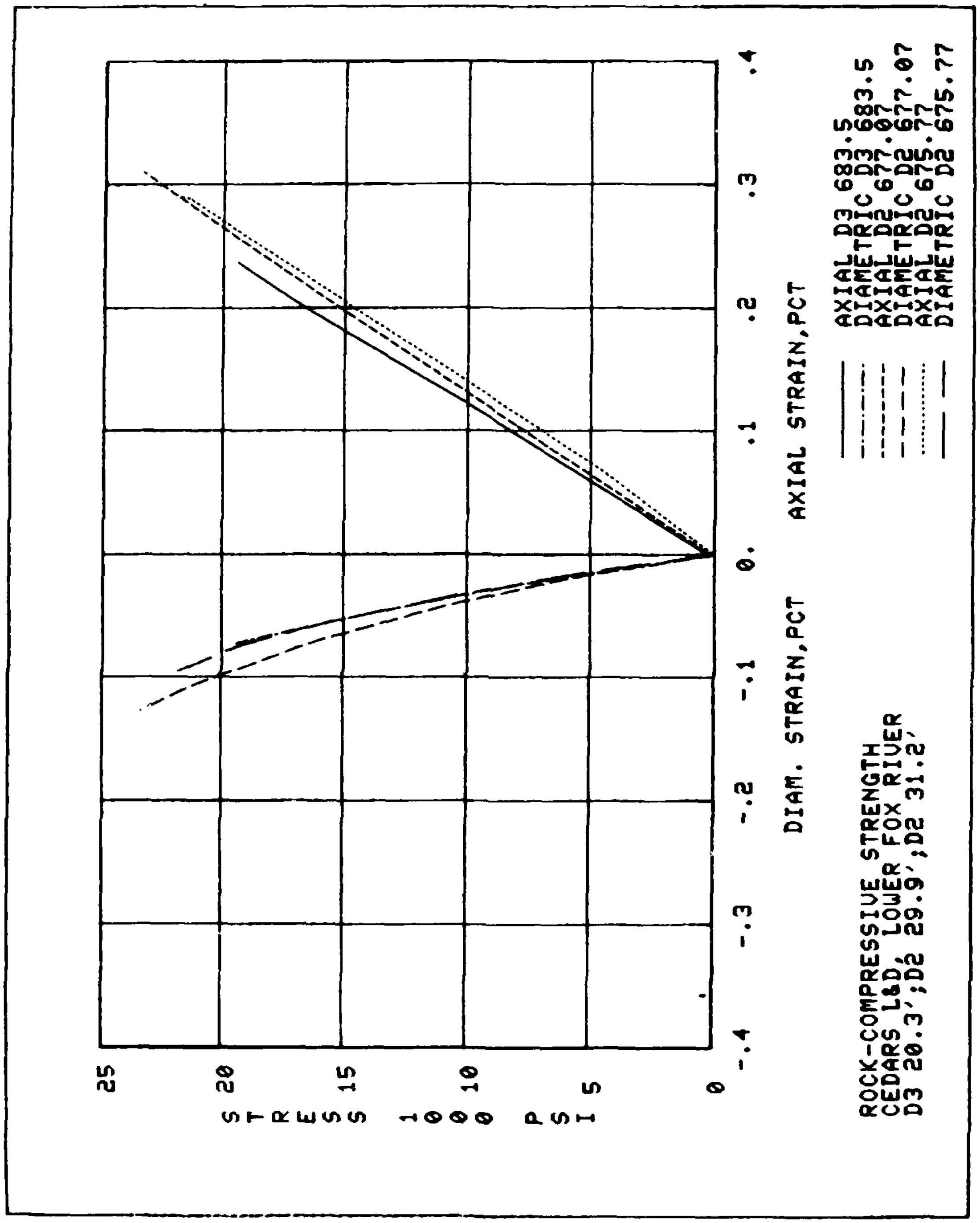
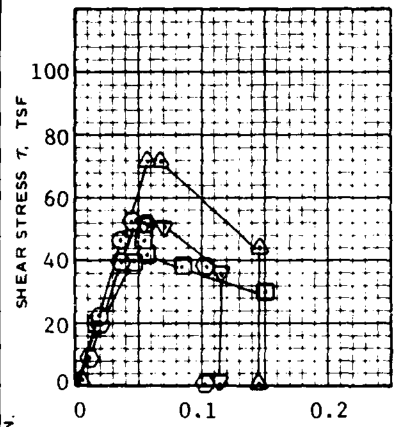
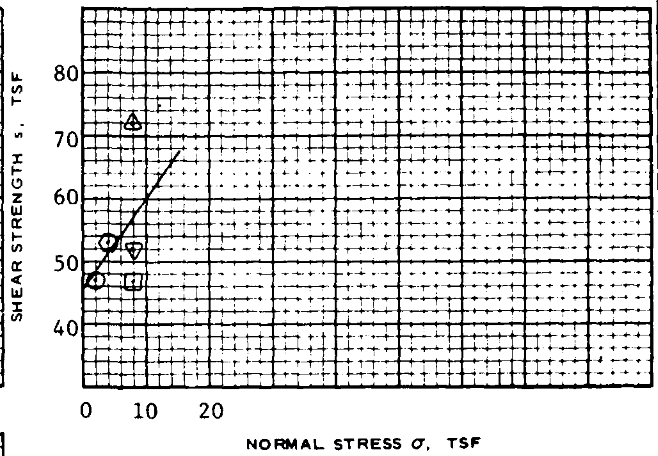
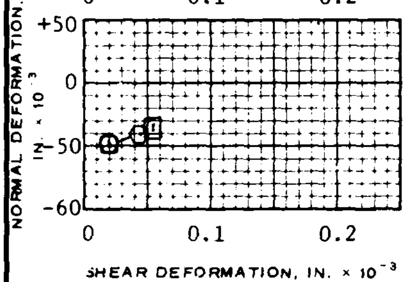

STRESS 1000 PSI
0
5
10
15
20
25
-.4
-.3
-.2
-.1
0.
.1
.2
.3
.4
DIAM. STRAIN,PCT
AXIAL STRAIN,PCT
AXIAL D3 683.5
DIAMETRIC D3 683.5
AXIAL D2 677.07
DIAMETRIC D2 677.07
AXIAL D2 675.77
DIAMETRIC D2 675.77
ROCK-COMPRESSIVE STRENGTH
CEDARS L&D, LOWER FOX RIVER
D3 20.3';D2 29.9';D2 31.2'

PLATE 21







⊙ ⊡ △ Typical expansion curves

SHEAR STRENGTH PARAMETERS

	MAXIMUM	ULTIMATE
ϕ =	56.2°	
TAN ϕ =	1.4938	
c =	45.6	TSF

TEST NO.	Boring No. / Elevation, ft	⊙ D2-80 681.6	⊙ E1-80 684.7	⊡ D1-80 685.7	△ D2-80 662.2	▽ D2-80 664.4	
WET DENSITY, PCF	γ_d						
WATER CONTENT	w	%	%	%	%	%	%
NORMAL STRESS, TSF	σ	2	4	8	8	8	
MAXIMUM SHEAR STRESS, TSF	τ_f	47.7	53.0	47.0	72.0	52.0	
TIME TO FAILURE, MINUTES	t_f	13.8	11.3	13.0	15.0	13.8	
ULTIMATE SHEAR STRESS, TSF	τ_r	--	--	--	--	--	
INITIAL DIAMETER, IN.	Do	3.95	3.95	3.95	3.95	3.95	
INITIAL HEIGHT, IN.	Ho	5.90	5.85	5.87	5.9	5.87	

DESCRIPTION OF MATERIAL Intact, type B bedding surface, dolomite

REMARKS Rate of strain 0.004 in/min. All specimens had a brittle failure; load noise and rapid decrease of shear load to zero at max deformation attained.

PROJECT Cedars Lock & Dam

Lower Fox River

AREA

BORING NO. See Test No.

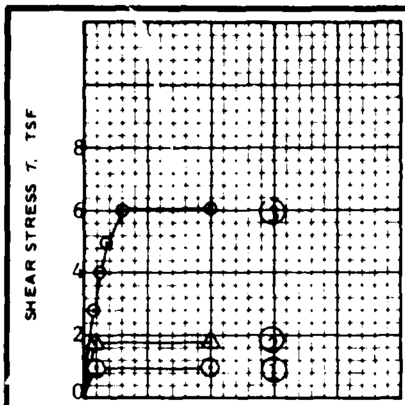
SAMPLE NO.

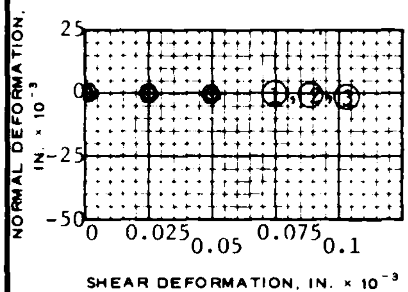
DEPTH EL See Test No.

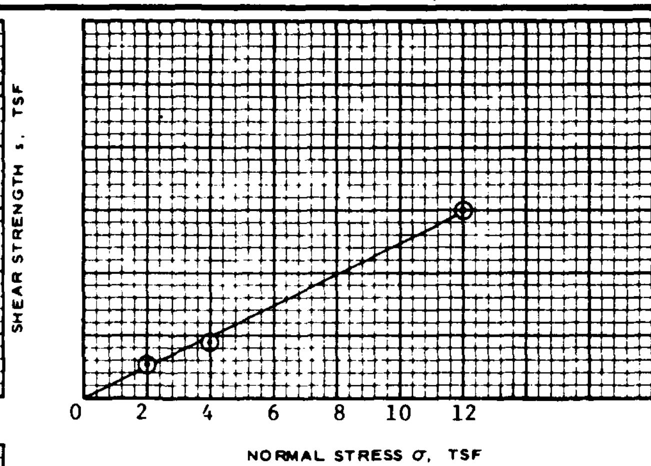
DATE March 1980

DIRECT SHEAR TEST REPORT (ROCK)

WES FORM APR 75 1490 EDITION OF JUN 65 IS OBSOLETE







SHEAR STRENGTH PARAMETERS

	MAXIMUM	ULTIMATE	
ϕ =	27.5°		
TAN ϕ =	0.5214		
c =	0		TSF

TEST NO.			1	2	3			
WET DENSITY, PCF	Concrete Rock	γ_d	153.0 171.0	153.4 170.3	154.0 171.7			
WATER CONTENT	Concrete Rock	w	5.1 0.5 %	5.2 0.6 %	4.8 0.6 %	%	%	%
NORMAL STRESS, TSF		σ	2.0	4.0	12.0			
MAXIMUM SHEAR STRESS, TSF		τ_f	1.1	1.8	6.2			
TIME TO FAILURE, MINUTES		t_f	8.5	35.0	23.0			
ULTIMATE SHEAR STRESS, TSF		τ_r	1.1	1.8	6.2			
INITIAL DIAMETER, IN.		Do	3.95	3.95	3.95			
INITIAL HEIGHT, IN.		Ho	5.90	5.91	5.90			

DESCRIPTION OF MATERIAL Concrete on rock, precut, dolomite

REMARKS

Test No.	Boring No.	Elevation Concrete	Elevation Rock
1	D1-80	686.6	683.1
2	D1-80	687.8	682.2
3	D2-80	692.9	683.0

Rate of strain = 0.004 in/min

PROJECT Cedars Lock & Dam

Lower Fox River

AREA

BORING NO.

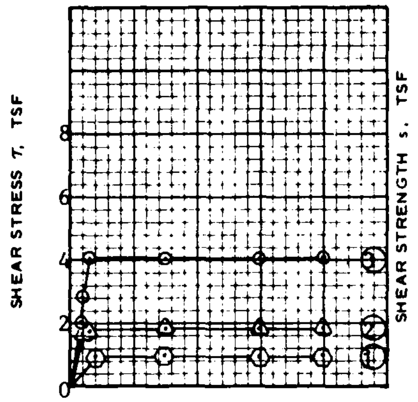
SAMPLE NO.

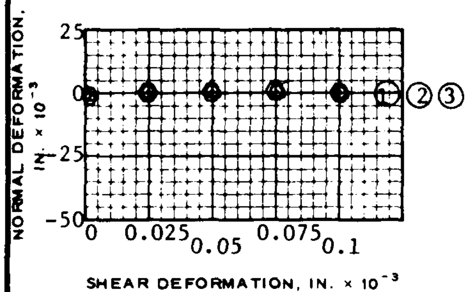
DEPTH
EL

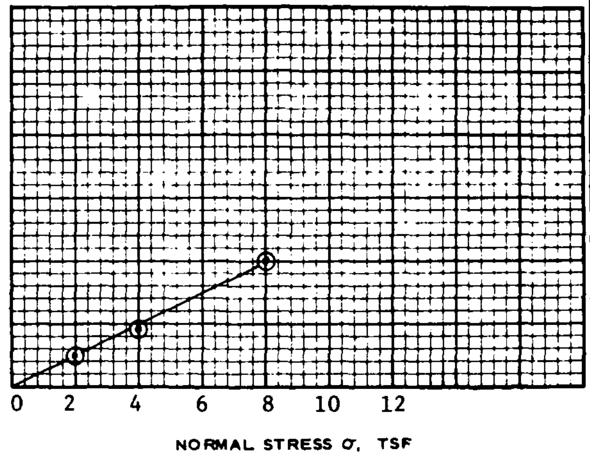
DATE 2/20,24,26/81

DIRECT SHEAR TEST REPORT (ROCK)

WES FORM APR 75 1490 EDITION OF JUN 65 IS OBSOLETE







SHEAR STRENGTH PARAMÊTERS

	MAXIMUM	ULTIMATE	
ϕ =	29.7°		
TAN ϕ =	0.5711		
c =	0		TSF

TEST NO.		1	2	3			
WET DENSITY, PCF	γ_d	170.8	172.4	171.5			
WATER CONTENT	w	0.7 %	0.6%	0.6 %	%	%	%
NORMAL STRESS, TSF	σ	2.0	4.0	8.0			
MAXIMUM SHEAR STRESS, TSF	τ_f	1.0	1.76	4.35			
TIME TO FAILURE, MINUTES	t_f	8.0	26.0	35.0			
ULTIMATE SHEAR STRESS, TSF	τ_r	1.0	1.76	4.35			
INITIAL DIAMETER, IN.	Do	3.95	3.95	3.95			
INITIAL HEIGHT, IN.	Ho	5.50	5.53	5.53			

DESCRIPTION OF MATERIAL Rock on rock, precut, dolomite

REMARKS

Test No.	Boring No.	Elevation ft
1	D2-80	676.6
2	D3-80	677.3
3	D3-80	678.1

Rate of strain = 0.004 in/min

PROJECT Cedars Lock and Dam
Lower Fox River

AREA

BORING NO.

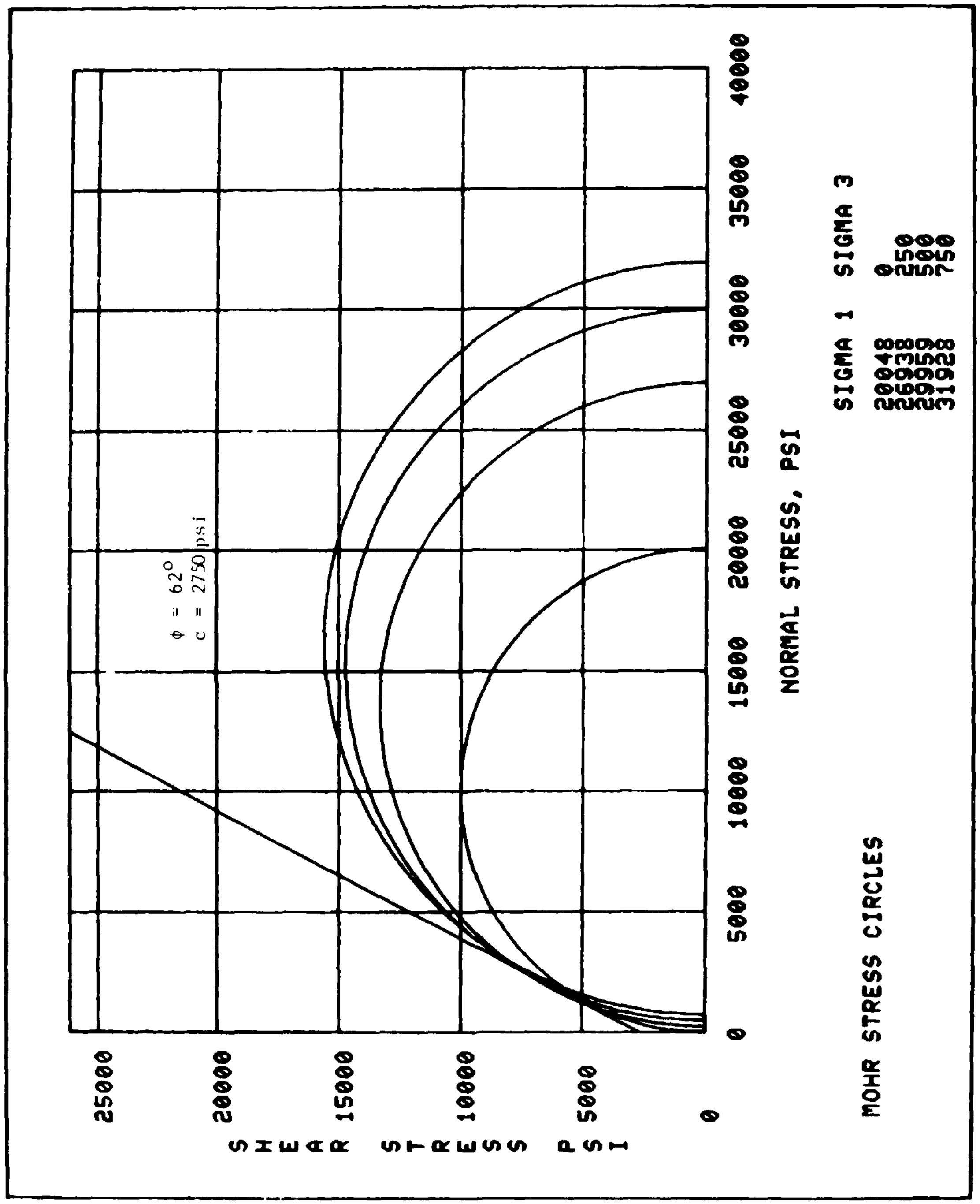
SAMPLE NO.

DEPTH
EL

DATE 2/2/81

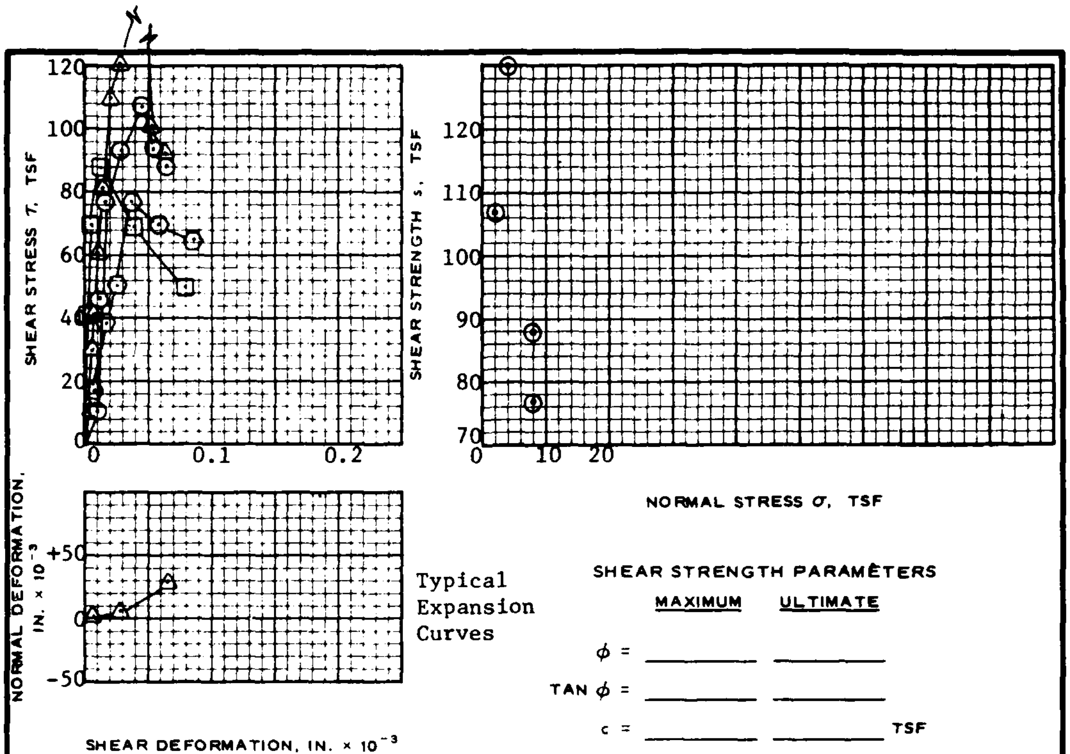
DIRECT SHEAR TEST REPORT (ROCK)

WES FORM APR 75 1490 EDITION OF JUN 65 IS OBSOLETE



MOHR STRESS CIRCLES
SHEAR STRESS PSI
NORMAL STRESS, PSI
0
5000
10000
15000
20000
25000
30000
35000
40000
$\phi = 62^{o}$
c = 2750 psi
SIGMA 1 SIGMA 3
20048 0
26938 250
29959 500
31928 750

PLATE 25



SHEAR STRENGTH PARAMETERS

	MAXIMUM	ULTIMATE	
ϕ =			
TAN ϕ =			
c =			TSF

TEST NO. Boring No. Elevation, ft		D1-80 674.9	D2-80 675.8	D1-80 676.0	D3-80 674.8		
WET DENSITY, PCF	γ_d						
WATER CONTENT	w	%	%	%	%	%	%
NORMAL STRESS, TSF	σ	2	4	8	8		
MAXIMUM SHEAR STRESS, TSF	τ_f	107	130	88	77		
TIME TO FAILURE, MINUTES	t_f	18	48	6	6		
ULTIMATE SHEAR STRESS, TSF	τ_r						
INITIAL DIAMETER, IN.	Do						
INITIAL HEIGHT, IN.	Ho						

DESCRIPTION OF MATERIAL Cross bedded, dolomite

REMARKS Rate of strain = 0.004 in/min

PROJECT Cedars Lock & Dam
Lower Fox River

AREA

BORING NO. See Test No. SAMPLE NO.

DEPTH EL See Test No. DATE March 1980

DIRECT SHEAR TEST REPORT (ROCK)

WES FORM APR 75 1490 EDITION OF JUN 65 IS OBSOLETE

APPENDIX A

PHOTOGRAPHS OF LOCK AND DAM

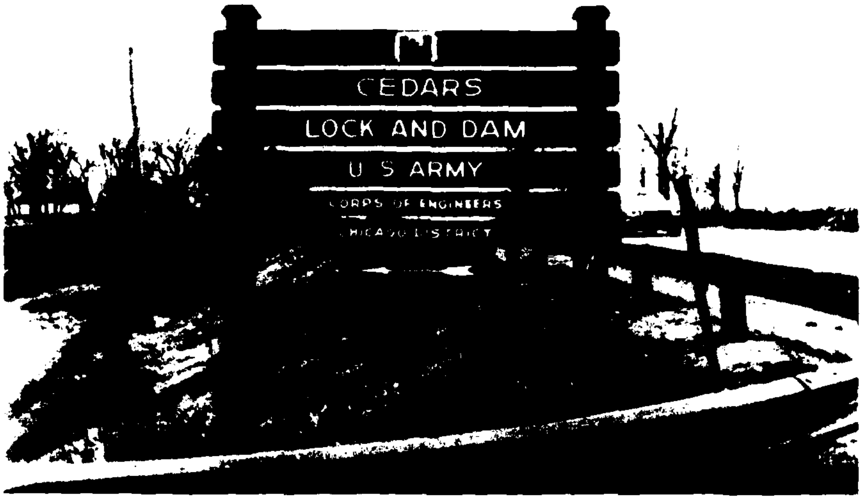


Photo 1. Entrance sign to Cedars Lock and Dam site

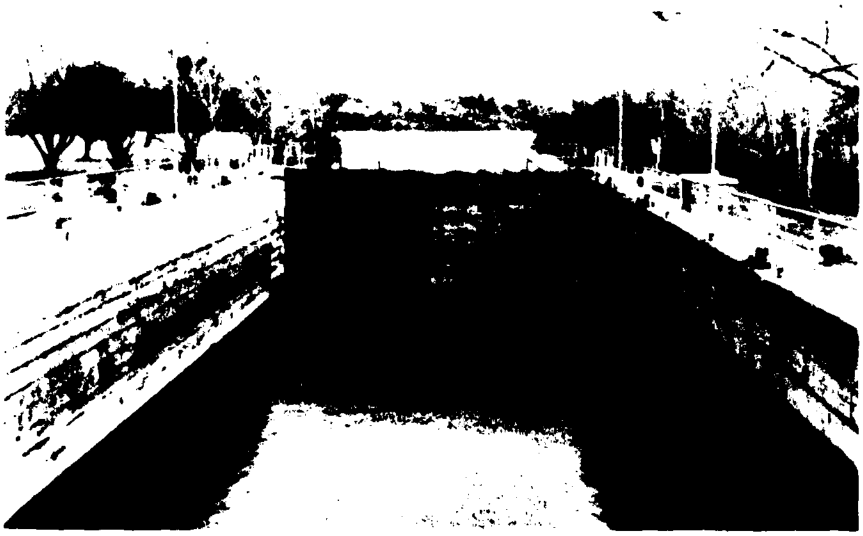


Photo 2. Taken from upstream gate looking downstream.
Lock in empty stage

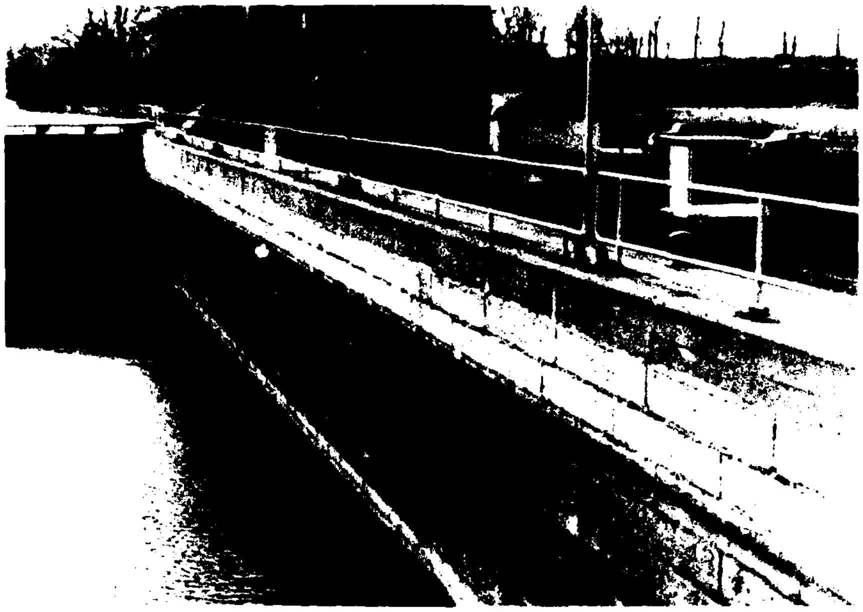


Photo 3. Taken from downstream gate looking upstream at the left lockwall. Close up showing good condition of masonry. Some joint mortar missing

Photo 4. Taken from right downstream bank, showing portion of downstream wooden gate and downstream lockwall. Masonry shown in good condition

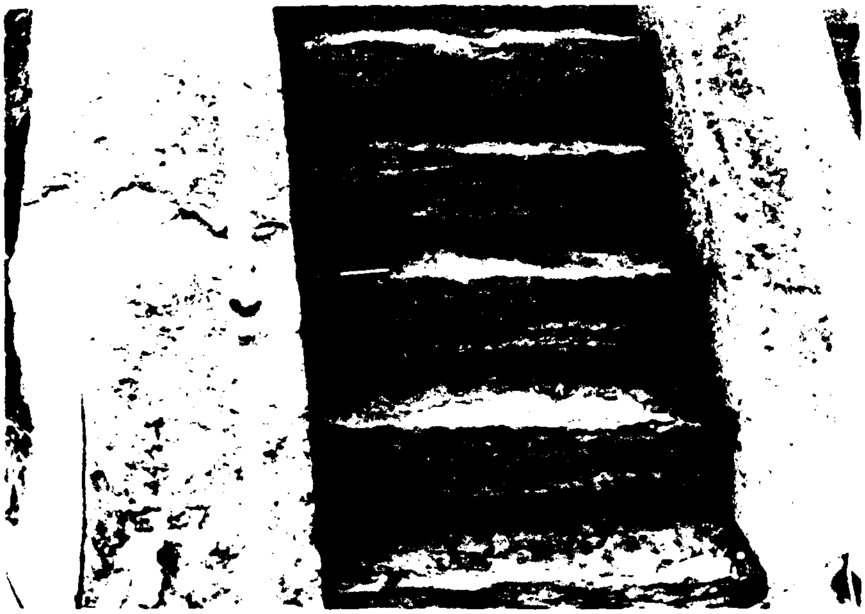


Photo 5. Taken from right downstream bank, showing stairway at end of right lockwall

Photo 6. Taken from right downstream embankment showing portion of stairway and embankment of right lockwall

Photo 7. Taken from upper right side of lock embankment, showing embankment slope and flat between embankment and river

Photo 8. Taken from upper left bank looking downstream, showing right approach wall and upper gate

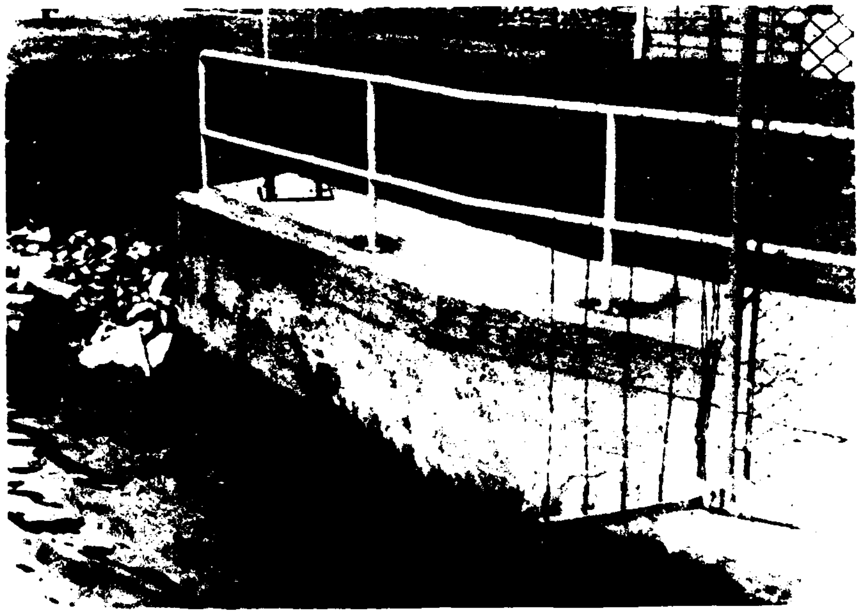


Photo 9. Taken from left spillway, looking at upstream portion of left abutment wall. Resurfaced and original concrete shows evidence of frost damage

Photo 10. Taken from foot bridge atop of left spillway, looking at downstream portion of left abutment wall. Resurfaced and original concrete shows evidence of frost damage

Photo 11. Taken from left spillway foot bridge looking north, pier No. 2, concrete in good condition

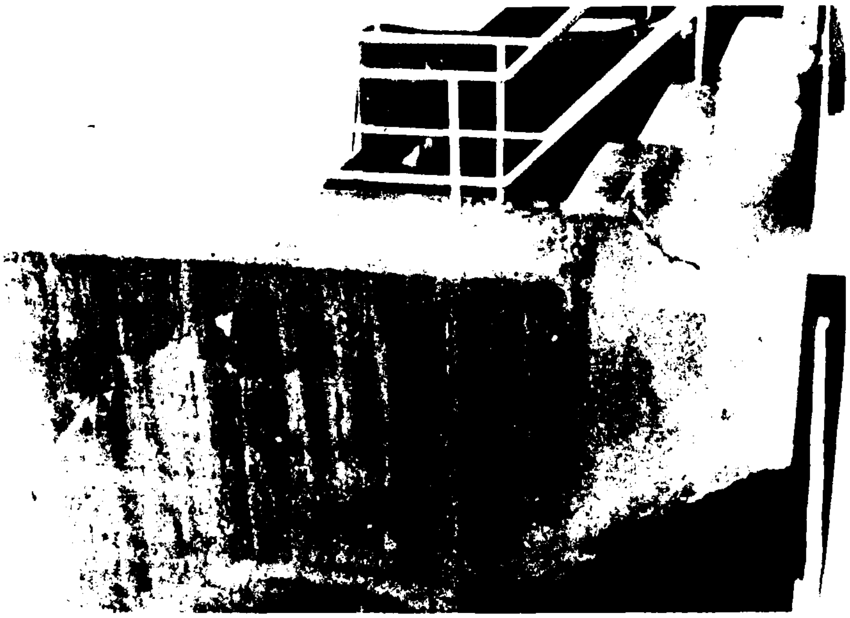


Photo 12. Taken from left spillway foot bridge, looking south, north side of sluiceway pier No. 1

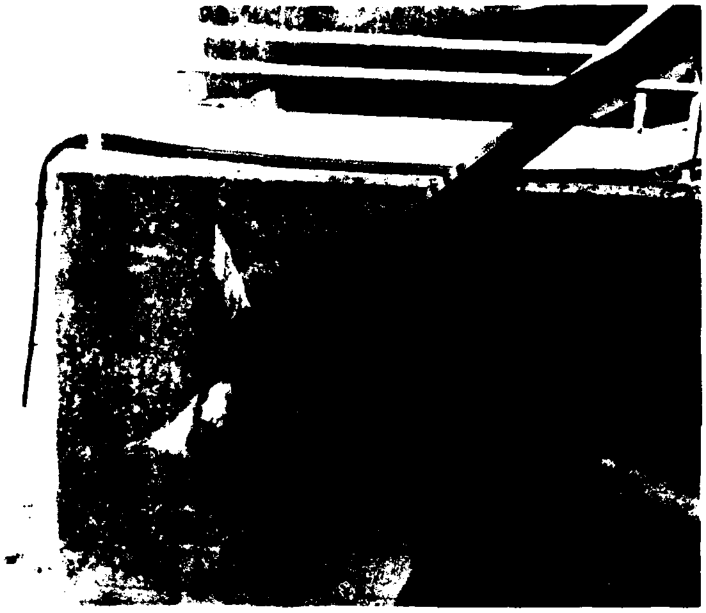


Photo 13. Taken from tainter gate pier No. 1, looking at north side of pier No. 2. Typical cracking through concrete pier at gate hinge pin

Photo 14. Taken from tainter gate pier No. 3, looking at south side of pier No. 2. Crack at gate hinge pin goes through pier

Photo 15. Taken from tainter gate pier No. 8, looking at south side of pier No. 7 showing crack through step of seventh pier

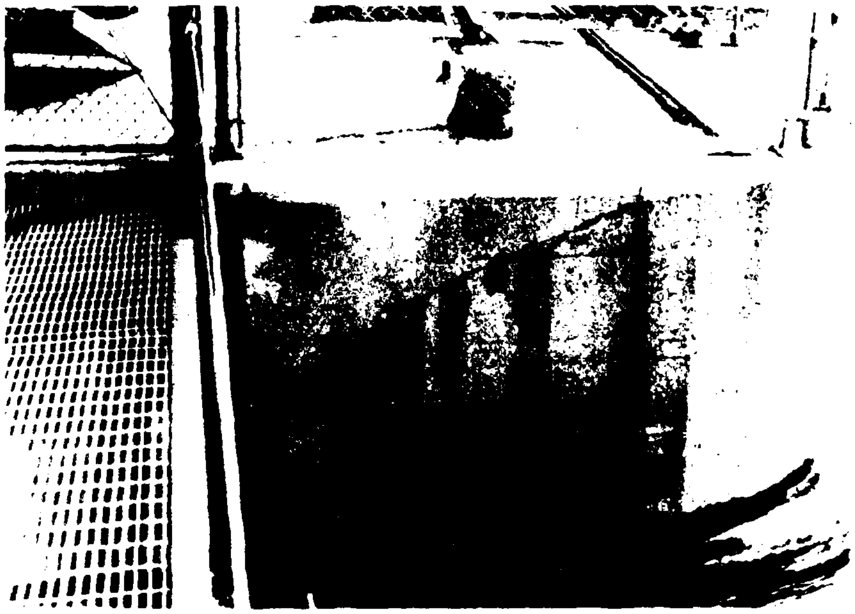


Photo 16. Taken from right spillway, looking at upstream portion of right abutment. Wide diagonal crack in concrete pier. Right dam abutment adjacent to Kimberly Clarke property

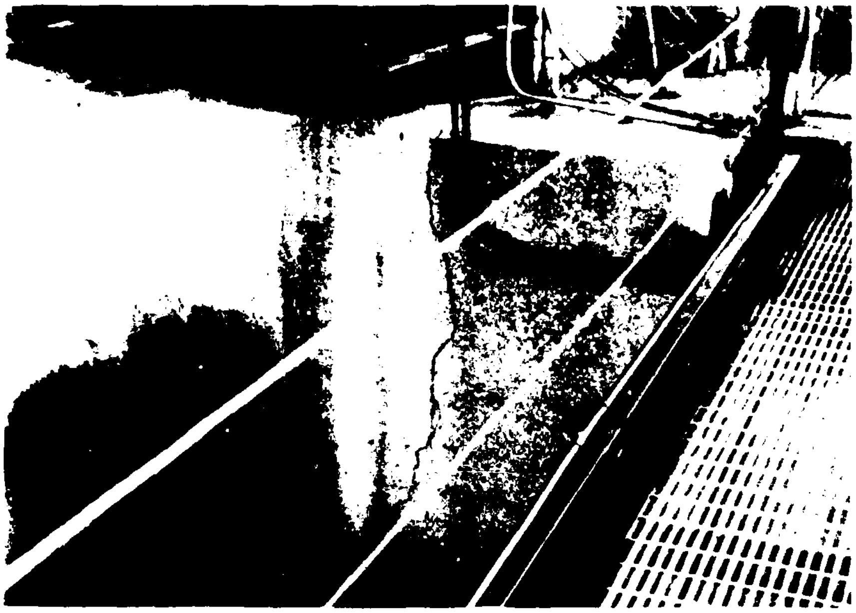


Photo 17. Taken from right spillway, looking at downstream portion of right abutment. Vertical crack to waterline in concrete pier

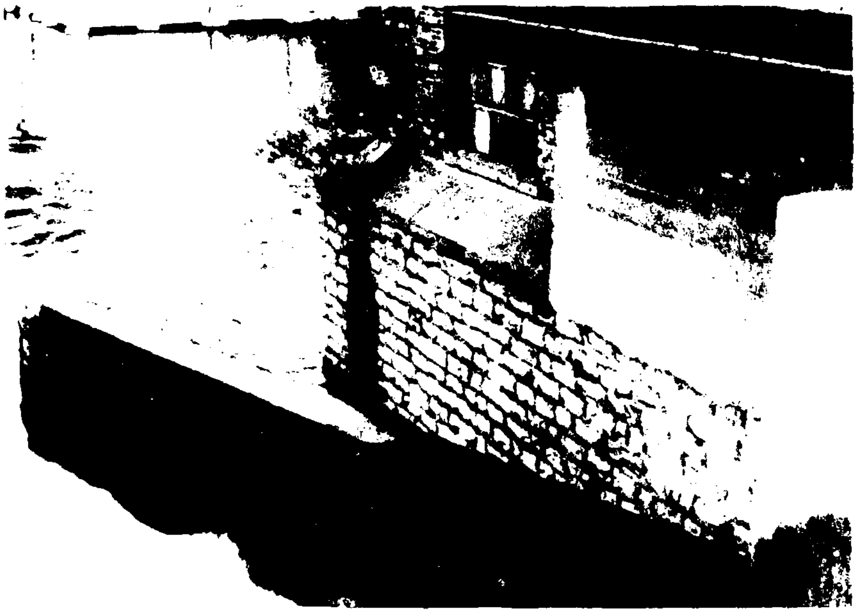


Photo 18. Taken from right spillway, looking at downstream portion of right abutment and masonry foundation wall of Kimberly Clarke plant

Photo 19. View of Murphy Concrete Co. Quarry about 1/4-mile from Kankauna Project Office, left side of Lower Fox River. The rock in the quarry is believed to be the Galena-Platteville dolomite. Horizontal bedding evident

Photo 20. Close-up view of quarry wall

Photo 21. View of dry dock area at the Kankauna Project Office. Downstream of wooden gate showing masonry construction of wall founded on horizontal rock foundation

Photo 22. View just downstream of Photo 21 showing typical bedding structure of founding rock. This rock formation is believed to exist beneath the Cedars Dam

APPENDIX B

DRILLING LOGS

NOTE: All field boring logs identify bedrock as limestone; subsequent petrographic examination shows the bedrock to be dolomite.

BORING LOG
FIELD DATA

Project Cedars Lock & Dam Site Cedars Lock & Dam - Little Chute - Wisconsin Date 2 August 1980
Location See Page # 10. Job No. 441-5763.306R22
Drill Rig H. Skidder Inspector Joe Dunbar Operator C Drake Surface El 704.0 - Boring No. 441-5763.306R22
C WES E-1-80

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Press.	Cont.	CLASSIFICATION AND REMARKS
1A	2 Aug	0.0	1.0	0.0	0.5	0.0	1.05	Shelby Tube	250	Tube	Organic Matter (Grass & Roots)
1B		1.0		0.5	1.0	1.05	1.15		300	Jar	Gravelly Clay - Reddish Brown
1C				1.0	1.5	1.9	2.5		380	Tube	Color with V. Little Cohesion.
				1.5	2.0				300		V. Dry Push: 2.5' Comp. 0.4'
				2.0	2.5				340		Spl 2.1'
				0.0	2.5	—	—	6" Fishtail	—	—	Cleanout
2A	2 Aug.			2.5	3.0	2.5	3.4	5" Hvorslev	100	Tube	Clay - (CL) - Same as above -
2B				3.0	3.5	3.4	3.5		120	Jar	Moisture Content increasing
2C				3.5	4.0	3.5	4.4		140	Tube	
2D				4.0	4.5	4.4	4.5		250	Jar	
				2.5	4.5	—	—	6" Fishtail	—	—	Cleanout
3A	4 Aug			4.5	5.0	4.5	4.6	5" Hvorslev	60	Jar	Clay (CL) - Same - Lg Piece of
3B				5.0	5.5	4.6	6.4		100		Gravel at top (2" x 1")

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED Sheet 1 of 10 Sheets

BORING LOG
FIELD DATA

Project Cedars Lock & Dam Site Cedar Lock Dam - Little Chute Wisconsin Date 2 Aug 1980
Location See Page #10 Job No. 44L 5763. 30. GR22
Drill Rig S/H Skid Rig Inspector Joe Dunbar Operator C. Drake Surface El 704.0 Boring No CWES-E1-80

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Press.	Cont.	CLASSIFICATION AND REMARKS
3C				5.5	6.0	6.4	6.5		/	JAR	
				6.0	6.5				500		PUSH. 2.0 COMP. 0.45 SPL 1.35'
				4.5	6.5	—		6" FISHTAIL	—		CLEANOUT
4A	4 Aug			6.5	7.0	6.5	6.6	HVORSLEV	275	JAR	CLAY ~ SAME ~ POOR SPL "CRUMBLY"
4B				7.0	7.5	6.6	7.5		325	TUBE	
4C				7.5	8.0	7.5	8.4		420	TUBE	PUSH 2.0 COMP: 0.3'
4D				8.0	8.5	8.4	8.5		500	JAR	SPL 1.5'
				6.5	8.5	—		6" FISHTAIL	—		CLEANOUT
5A				8.5	9.0	8.5	10.4	HVORSLEV	180	TUBE	GRAVELLY SAND. CLAY — (CL)
5B				9.0	9.5	10.4	10.5		280	JAR	POORLY GRADED IN SIZE — GRADUAL
				9.5	10.0				300		CHANGE WITH DEPTH: GRAVEL IS
				10.0	10.5				250		MED IN SIZE & APPROX 10%
											PUSH: 2.0 COMP 0.45' SPL 1.45'

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED Sheet 2 of 10 Sheets

BORING LOG
FIELD DATA

Project Cedars Lock & Dam Site Cedars Lock & Dam - Little Chute, Wisconsin Date 2 August 80
Location See page #10 Job No. 491.57630.6822
Drill Rig SH. Skid Rig Inspector Joe Dunbar Operator C. Drake Surface El 704.0 - Boring No. CWES-E-1-80

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
				8.5	10.5	—	—	6" Fishtail	—		Cleanout
6A	4 Aug		10.0	10.5	11.0	10.7	12.4	5" Hvorslov	120	Tube	Gravelly Sand - Brown,
6B		10.0		11.0	11.5	12.4	12.5		140	Jar	Fine to Coarse Sand, Moderate
				11.5	12.0				50c		Cohession. Gravel is fine to med. in
				12.0	12.5				45c		size (Lms). Stratum change depth
											is gradual — Push: 2.0'
											Comp. 0.55' Spl 1.30'
				10.5	12.0	—		6" Fishtail	—		Cleanout
	4 Aug			12.0	12.5	—		5" Hvorslov	390		No Sample
				12.5	13.0				250		
				13.0	13.5				300		
				13.5	14.0				325		
7	4 Aug			12.5	14.5			Splitspoon	—	Jar	Coarse Sand - Sand (SW)

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 3 of 16 Sheets

BORING LOG
FIELD DATA

Project Cedar Lock & Dam Site Cedar Lock - Dam Date 2 Aug 1980
Location See page #10 Job No. 441.5763.30.6022
Drill Rig Skidrig Inspector Joe Dunbar Operator C. Drake Surface El 704.0 Boring No. WES-E1-80

SAMPLE NUMBER	DATE TAKEN 7/80	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
				—	14.5	—		Fishtail	—		Cleanout - Hole kept falling
											in
	5 Aug			12.5	13.0	—	—	5" Drive Bbl	—		Cuttings
				—	14.7	—		5½" x 4" Core Bbl	—		Blocked off on Lms Cobble -
											Boulder - Bd Rk.
				0.0	14.65	—		8¾" Rock Bit	—	—	Bd Rk starts at 14.35'
				0.0	14.6	—	—	8" Casing	—		Total 16.45' Stickup: 1.85'
				—	15.3	—		6½" Rock Bit	—		Cleanout
				15.3	20.3			5½" x 4" Core Barrel	—		Lms -> (See other logs)
				—	17.9	—		6½" Rk Bit	—		Rk Bit
				—	20.7	—		5½" x 4" Core Bbl			Lms - Rec. 0.45 - Blocked off

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED Sheet 4 of 10 Sheets

& Fell in.

BORING LOG
FIELD DATA

Project CEDARS LOCK & DAM   Site Cedars Lock & Dam - Little Chute Wisconsin   Date 2 Aug 1980
Location See Page #10   Job No. 441.5763.3a.GR22
Drill Rig SH. Skid rig   Inspector Joe Dunbar   Operator C. Drake   Surface El 704.0 -   Boring No. CWESE-1-80

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
				/	20.6	—	—	6½" Rk Bit	—		CLEANOUT
				14.60	17.25	—	—	8" Casing	—		Beat Cs with 300# Hammer
				/	20.75			6½" Rock Bit	—		CLEANOUT
				20.75	40.1			5½" x 4" Bbl			LABS - SEE OTHER LOG.

WES FORM JAN 74 819   EDITION OF NOV 1971 MAY BE USED

Sheet 5 of 10 Sheets

Hole No. CEDARS E-1-1980

DRILLING LOG	DIVISION: DETROIT	INSTALLATION: CEDARS LOCK DAM	SHEET 6 OF 6 SHEETS

1. PROJECT: CEDARS LOCK DAM	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station): SEE PAGE TEN —	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CEWES	12. MANUFACTURER'S DESIGNATION OF DRILL: S + H
4. HOLE NO. (As shown on drawing title and file number): CWES-E1-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED: SIX PUSHES; UNDISTURBED: ONE
5. NAME OF DRILLER: C. DRAKE	14. TOTAL NUMBER CORE BOXES: SIX
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: ——
	16. DATE HOLE — STARTED: 2 Aug 80; COMPLETED: 7 Aug 80
7. THICKNESS OF OVERBURDEN: 17.4'	17. ELEVATION TOP OF HOLE: 704.0
8. DEPTH DRILLED INTO ROCK: 26.7'	18. TOTAL CORE RECOVERY FOR BORING: 100 %
9. TOTAL DEPTH OF HOLE: 44.1	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
704.0	0.0		CLAY + ORGANIC MATTER			Note: Rock type is Dolomite, not Limestone as shown on field logs.
703.0	1.0					
			CLAY (CL)			See boring log for details
694.0	10.0					
			SAND – (SW)			
689.0	15.0					
688.0	16.0		SAND GRAVEL & WEATHERED LIMESTONE. Recovered Approx 10' of Coarse Gravel + Fine Cobbles			WL — ; Begin 12 51; End 1 31; Time 40 min; Dril time 40 min; Hyd press 50-200 PSI; Water press —; RPM 30-200; Dril Action Smooth; Water ret Lt Brown/white; Run 4.9'; Rec 2.8; Loss —; Gain —
687.0	17.0	NB	CORE STARTS HERE			Remarks: Core Bbl. on Second run encountered Fall-in. Ran Rock Bit Back in and cleared out. (See Soil boring logs)
686.0	18.0	NB	— WEATHERED —	57	Box 1	
		NB	LIMESTONE			
		NB	RQD = 64 (Based on whole core sticks)			
685.0	19.0	NB				
684.0	20.0	NB				

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CLWES
Hole No. E1-1980

DRILLING LOG	DIVISION: DEtroit	INSTALLATION: CEDARS Lock + Dam	SHEET 7 OF 10 SHEETS

1. PROJECT: CEDARS LOCK + DAM	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station): SEE PAGE TEN —	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CENCS	12. MANUFACTURER'S DESIGNATION OF DRILL: S+H
4. HOLE NO. (As shown on drawing title and file number): CWES-E1-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED: Six Pushes; UNDISTURBED: One
5. NAME OF DRILLER: C. DRAKE	14. TOTAL NUMBER CORE BOXES: Six
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED: 2 Aug 80; COMPLETED: 7 Aug 80
7. THICKNESS OF OVERBURDEN: 17.4'	17. ELEVATION TOP OF HOLE: 704.0
8. DEPTH DRILLED INTO ROCK: 26.7'	18. TOTAL CORE RECOVERY FOR BORING: 100 %
9. TOTAL DEPTH OF HOLE: 44.1	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
684.0	20.0		Run #1			
			Run #2		Box	
			2 - No core - Rock Bit		1	
683.0	21.0					Run #2
		NB NB			20.3	WL; Run 4.5'; Began 3:51; Rec 4.5; End 4:20; Loss —; Time 29min; Gain —
			SHALEY LIMESTONE			Dril time 29min; Dril press 200PSI; Water press —; RPM 100±
682.0	22.0	NB	RQD=88.9%	100	Box	Dril Action Semi Smooth
		NB	Fine Grained, Grey in color, dense, Sugary Texture, Fossiliferous,		2	Water ret Lt. Brn/Wht
681.0	23.0	NB	with Shale (v competent) Layers/Beds/Lamina/Stringers - through-out cores Length - Breaks			Remarks Blocked off. - Fell-in "
		NB	Are caused By Shaley Areas			
			CH			
680.0	24.0	NB				Run #3
			Run #3			WL; Run 4.2; Began 9:59; Rec 4.2; End 10:40; Loss —; Time 41min; Gain —
679.0	25.0	NB NB				Dril time 41min; Dril press 80-120±; Water press —; RPM 75-100
						Dril Action Smooth
678.0	26.0	NB			25.5	Water ret Milky white/Grey
			Shaley Lms			Remarks
		NB	CH			
677.0	27.0	NB NB	KQD-70.7%	100	Box 3	
						Run #4
676.0	28.0	NB NB				WL —; Run 4.95; Began 11:02; Rec 4.95; End 11:47; Loss —; Time 45min; Gain —
		NB				Dril time 45min; Dril press 80-120±; Water press —; RPM 75
675.0	29.0					Dril Action Smooth
			Run 4			Water ret Milky white/Grey
674.0	30.0	NB				Remarks

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Hole No. Ce:12065 E1-1880

DRILLING LOG

DRILLING LOG	DIVISION: Detroit	INSTALLATION: Cedars Lock + Dam	SHEET 8 OF 10 SHEETS

1. PROJECT: CEDARS LOCK + DAM
2. LOCATION (Coordinates or Station): See PAGE TEN -
3. DRILLING AGENCY: CEWES
4. HOLE NO. (As shown on drawing title and file number): CWES-E1-80
5. NAME OF DRILLER: C. DRAKE
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 17.4'
8. DEPTH DRILLED INTO ROCK: 26.7'
9. TOTAL DEPTH OF HOLE: 44.1
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: S+H
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: Six Pushes; UNDISTURBED: ONE
14. TOTAL NUMBER CORE BOXES: Six
15. ELEVATION GROUND WATER: ——
16. DATE HOLE: STARTED 2 Aug 80; COMPLETED 7 Aug 80
17. ELEVATION TOP OF HOLE: 704.0
18. TOTAL CORE RECOVERY FOR BORING: 100 %
19. SIGNATURE OF INSPECTOR:

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
674.0	30.0		NB NB NB		30.3	
673.0	31.0		NB Shaley Lms LH			Run #5 WL Began 127 End 142 Time 40min Drl time 40min 50-120 — 75% Drl Action Smooth Water Ret Lt Grey/Milky wh.t Remarks Rcl 4.6 Rec 4.6 Loss — Gain —
672.0	32.0		NB RQD- 93.5%	100%	Box 4	
671.0	33.0		NB NB			
670.0	34.0		Run #5			
			NB NB Limestone			
669.0	35.0		NB NB		34.75	
			SHALE (GREY GREEN) NB			
668.0	36.0		NB SHALE (GREY GREEN) NB NB SHALE REDDISH ORANGE STAIN AT BREAK SURFACE SH — SHARP CONTACT (WELL DEFINED)			Run #6
667.0	37.0		DARK GREY IN COLOR Limestone	100%	Box 5	Rcl 5.2 — Rec 5.2 — Began 214 248 -3 — 75% Smooth Lt Grey/wh.t
666.0	38.0		NB NB RQD- 48.1% NB			
665.0	39.0		Run #6		39.2	
664.0	40.0		Limestone NB			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. E1-1980

DRILLING LOG	DIVISION	INSTALLATION Cedars Lock & Dam	SHEET 9 OF 10 SHEETS

1. PROJECT Cedars Lock & Dam	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station) See Page TEN —	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY CENES	12. MANUFACTURER'S DESIGNATION OF DRILL S&H
4. HOLE NO. (As shown on drawing title and file number) CNES-E1-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED: Six Pushes; UNDISTURBED: One
5. NAME OF DRILLER C. DRAKE	14. TOTAL NUMBER CORE BOXES Six
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER —
	16. DATE HOLE — STARTED 2 Aug 80; COMPLETED 7 Aug 80
7. THICKNESS OF OVERBURDEN 174'	17. ELEVATION TOP OF HOLE 704.0
8. DEPTH DRILLED INTO ROCK 267'	18. TOTAL CORE RECOVERY FOR BORING 100 %
9. TOTAL DEPTH OF HOLE 441	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
664.0	400	MB	Run #7	2.16%		Run 7 — WL; Began 335; End 420; Time 45min; Drill time 45min; Hol[d] p[ress] 50 mcPSI; Water press —; RPM 75; Dril Action Smooth; Water ret Lt Gray/Milky White; Remarks: Catcher Slipped — wouldn't hold core; Run 49; Rec 135; Loss 355; Gain —
663.0	410	MB, MB	Shaley Limestone		Box 6	
662.0	420	MB	" "	10%		
661.0	430	MB, MB				Run 8 — 4.35; 4.55; 20min; 20min; 350PSI; —; 50; Smooth; Water ret Lt Gray/White; Remarks: Caused cover Run #7; Run 355; Rec 355; Loss —; Gain —
660.0	440	MB	Run #7+8		End	
659.0	450		Total Core Recovery is 100%			
658.0	460					
657.0	470					
656.0	480					
655.0	490					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO

BORING LOG
FIELD DATA

Project Cedars Lock and Dam Site Cedars Lock, Little Chute, WI Date 16 August 80
Location See Page #4 Job No. 4W-5763.306027
Drill Rig Acker Inspector J. Dunbar Operator Clyde Drake Surface El 702.8' Boring No. LWES-E2-80

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Pass	Cont.	CLASSIFICATION AND REMARKS
#1	16Aug	0.0	1.0	0.0	0.5	0.2	2.4	5" diam Shelby	225	Tube	Organic Matter - Clay/Silt, low
#1A		1.0		0.5	1.0	2.4	2.5	Tube	400	Jar	plasticity, Brown, dry, little cohesion
				1.0	1.5				450		Push 2.5' Comp 0.8' SPL 1.7'
				1.5	2.0				550		
				2.0	2.5				700		
				0.0	2.5	—		6" Fishtail	—		Cleanout
#2	18Aug			2.5	3.0	2.7	4.9	5" Hvorslev	400	Tube	Clay/Silt (ml/cl) Brown, dry,
#2A				3.0	3.5	4.9	5.0		450	Jar	moderate cohesion, with low
				3.5	4.0				600		plasticity, and soft.
				4.0	4.5				650		
				4.5	5.0				980		Push: 2.5' Comp 0.95 SPL 1.55
				2.5	5.0	—		6" Fishtail	—		Cleanout

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED Sheet 1 of 4 Sheets

AD-A119 696 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/G 13/2
CONDITION SURVEY OF CEDARS LOCK AND DAM, LOWER FOX RIVER, WISCO--ETC(U)
JUN 82 R L STOWE, J C AHLVIN
UNCLASSIFIED WES/MP/SL-82-4 CTIAC-52 NL

2 OF 2
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BORING LOG
FIELD DATA

Project Cedars Lock & Dam Site Cedar Lock & Dam Little Chute Wisconsin Date 16 August 1983

Location See Page #4

Drill Rig Acker Inspector Joe Dunbar Operator Clyde Drake Surface El 702.8' Job No. 441.5763.30.ER72 Boring No. CWES-E2-80

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Press	Cont.	CLASSIFICATION AND REMARKS
3	18Aug			5.0	5.5	5.0	5.8	5" Hvorslev.	500	Tube	
3A				5.5	6.0	5.8	6.1		525	Jar	Clay — Reddish Brown, Soft,
3B				6.0	6.5	6.1	7.2		650	Tube	Little to no cohession, Low plast.
3C				6.5	7.0	7.2	7.3		700	Jar	Sample fell apart in handling
				7.0	7.5				850		Push. 7.5 Comp. 0.2' Spl. 7.3
				5.0	7.5	—		6" Fishtail	—		Cleanout
4	19Aug		8.4	7.5	8.0	7.55	8.5	5" Hvorslev	500	Tube	Clay — Sand - Lms Cobbles -
4A		8.4		8.0	8.5	7.5	7.55		700	Jar	boulders — Gravel.
				8.5	8.65				1000+		
5	18Aug			8.65	11.35	8.65	11.35	Drive Bbl	/	Bag	Clay + Lms Rip Rap (Gravel -
											Cobbles, + Boulders)
6	18Aug			11.35	16.35	11.35	16.35	Drive Bbl	/	Bag	Clay (20%) Lms (80%) Rip Rap.
											Recovered Approx 1/8 to 1/4 Bag.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 4 Sheets

BORING LOG
FIELD DATA

Project Cedar Lock + Dam Site Cedar Lock + Dam Little Chute Wisconsin Date 16 August 1980
Location See page #1 Job No. 441-5763-30-GR22
Drill Rig Acker Inspector J. Dunbar Operator Clyde Duke Surface El 702.8' Boring No. CWES-EZ-80

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
7	18 Aug		18.65	16.35	18.65	16.35	18.65	Drive Bbl	/	Bag	Clay + Lms. Rip Rap - Stopped
											@ 18.65
				18.65	23.75	18.65	23.75	5½ x 4" Core		Box	Limestone - See Drill Logs
								Bbl			

Note: All Pressure Readings are Representative of Bit Weight

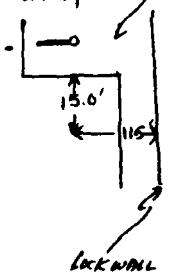
WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 3 of 4 Sheets

Hole No. CWCS-E2-80

DRILLING LOG	DIVISION: Detroit	INSTALLATION: Cedars Lock & Dam	SHEET 1 OF 1 SHEETS

1. PROJECT: CEDARS LOCK & DAM	10. SIZE AND TYPE OF BIT: 5 1/2 x 4" 21NS 3/BR1134
2. LOCATION (Coordinates or Station): See Location	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL [redacted]
3. DRILLING AGENCY: C.E. W.C.S.	12. MANUFACTURER'S DESIGNATION OF DRILL: Fk RR
4. HOLE NO. (As shown on drawing title and file number): CWCS-E2-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — ; UNDISTURBED
5. NAME OF DRILLER: CLYDE DRAKE	14. TOTAL NUMBER CORE BOXES: One
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 16 Aug 80; COMPLETED 18 Aug 80
7. THICKNESS OF OVERBURDEN: 18.65	17. ELEVATION TOP OF HOLE: 702.61
8. DEPTH DRILLED INTO ROCK: 5.1	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 23.75	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
702.8	0.0		Cl/ml			
	8.4		Lms Cobbles - Boulders - Gravel Lms 60 to 80% cl/ml 20 to 40%			
	18.65	NB				
683.8	19.0	NB				Run #1 WL Began 1:00 Run 5.1 End 1:35 Rec 5.1 Time 35min Loss — Gain — Drl time 35min Hyd press 250psi Water press — RPM 70?
682.8	20.0	NB	Shaley Lms: Fine to med grained, grey to greenish grey in color, moderately hard, dense & contains numerous shaly zones/beds/laminae which control breaks in core.			Drl Action Smooth Water ret ✓ Remarks ✓
681.8	21.0	NB				
680.8	22.0	NB				LOCATION Left lower gate hand crank pad
679.8	23.0	NB	Run #1			
678.8	24.0		LEGEND ▦ · LIMESTONE NB · Natural Break			

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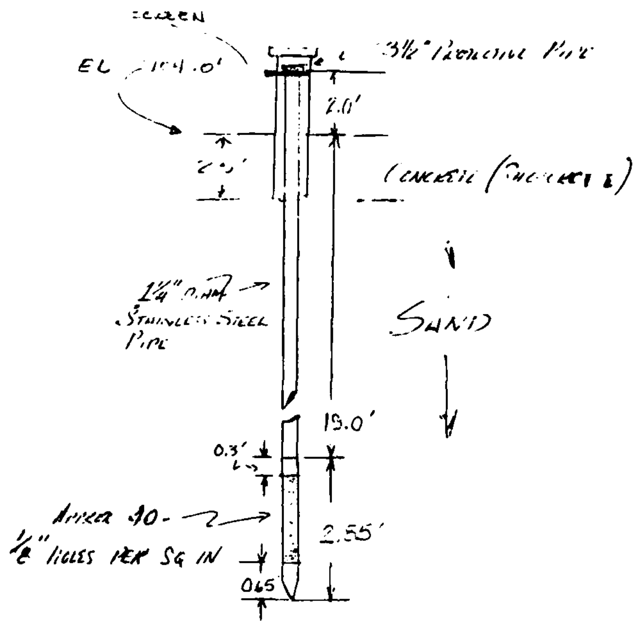
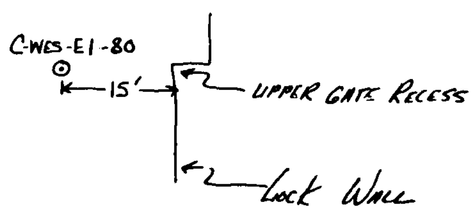
Piezometer P-1 - Cedars Lock and Dam



LOCATION



Hole No. CWES-D1-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock & Dam	SHEET 1 of 4 SHEETS

1. PROJECT Cedars Locks Dam	10. SIZE AND TYPE OF BIT 6 x 7¾" - Bit - BS
2. LOCATION (Coordinates or Station) See Bottom of Page #4	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) M.S.L. 5½" x 4" Bit 782BS for 1.54
3. DRILLING AGENCY C.E.W.E.S.	12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood
4. HOLE NO. (As shown on drawing title and file number) CWES-D1-80	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED —
5. NAME OF DRILLER Clyde Drake	14. TOTAL NUMBER CORE BOXES Nine
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER Lake Level
	16. DATE HOLE STARTED 11 August 80 COMPLETED 12 Aug 80
7. THICKNESS OF OVERBURDEN Concrete 17.65	17. ELEVATION TOP OF HOLE 703.8
8. DEPTH DRILLED INTO ROCK 20.10	18. TOTAL CORE RECOVERY FOR BORING 99.3 %
9. TOTAL DEPTH OF HOLE 37.75'	19. SIGNATURE OF INSPECTOR Gary L.B. Dunbar

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
703.8	0.0	Δ	Concrete			Run #1 WL — Run 2.35' Began 3.05 Rec 2.35 End 3.30 Loss — Time 25 min Gain — Drl time 25 min Hyd press 80-125 PSI Water press — RPM 70± Drl Action Smooth Water ret Lt. Brown Remarks 6" x 7¾" Bbl
702.8	1.0	Δ		100%	Box 1	
701.8	2.0	Δ	Run #1 RQD: 100%			
700.8	3.0	Δ		100%	Box 1	Run #2 WL Run 2.35 Began 3:35 Rec 1.95 End 4.10 Loss 0.4 Time 35 min Gain — Drl time 30 min Hyd press 60-125 PSI Water press — RPM 70± Drl Action Smooth Water ret Lt Brown Remarks 6 x 7¾" Bbl Broke off
699.8	4.0	Δ	Run #2 RQD: 100%		4.3	
		Δ	Run #3	100%		
698.8	5.0	Δ				Run #3 WL — Run .35 Began 4.22 Rec .35 End 4.37 Loss — Time 15 min Gain — Drl time 10 min Hyd press 80-100± Water press — RPM 70± Drl Action Smooth Water ret Lt Brown Remarks
697.8	6.0	Δ NB			Box 2	
696.8	7.0	Δ	Concrete: Gray Brown in color with Natural Agg. Reaction Product Visible - Slight.	100%		
695.8	8.0	Δ NB			8.45	Run #4 WL Run 4.85' Began 4.45 Rec 4.85' End 5.14 Loss — Time 29 min Gain — Drl time 29 min Hyd press 60 K! Water press — RPM 100± Drl Action Smooth Water ret Lt. Brown Remarks
694.8	9.0	Δ	Run #4 RQD: 100%			
693.8	10.0	Δ				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) PROJECT HOLE NO.

Hole No. CWES-01-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock & Dam	SHEET 2 of 4 SHEETS

1. PROJECT: Cedars Lock & Dam
2. LOCATION (Coordinates or Station): See bottom of page #4
3. DRILLING AGENCY: C.E. W.E.S.
4. HOLE NO. (As shown on drawing title and file number): CWES-01-80
5. NAME OF DRILLER: CLYDE DRAKE
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF ~~OVERBURDEN~~: Concrete 17.65'
8. DEPTH DRILLED INTO ROCK: 20.10'
9. TOTAL DEPTH OF HOLE: 37.75'
10. SIZE AND TYPE OF BIT: 6 x 7 3/4" - BX-RS-
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): M.S.L. 5 1/2 x 4" Bttmls Series 1234
12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague + Henwood
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: Nine
15. ELEVATION GROUND WATER: Lake Level
16. DATE HOLE: STARTED 11 August 80 COMPLETED 12 Aug 80
17. ELEVATION TOP OF HOLE: 703.8
18. TOTAL CORE RECOVERY FOR BORING: 99.3 %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
693.8	10	Δ				12 August 1980 Run #5
692.8	11	Δ	CONCRETE		Box 3	WL — Run 5.05' Rec 5.05' Began 7:46 End 8:16 Loss — Time 30 min Gain — Drl time 28 min Hyd press 80± Water press — RPM 70± Drl Action Smooth Water ret Lt. Brown/White Remarks
691.8	12	Δ	NB	100%	12.7	
690.8	13	Δ	NB		Box 4	
689.8	14	Δ	NB. Run #5 RQD = 100%			
688.8	15	Δ	2 closed			Run 6 WL — Run 5.0' Began 8:27 Rec 5.0' End 9:00 Loss — Time 33 min Gain — Drl time 33 min Hyd press 100 PSI Water press — RPM 70± Drl Action Smooth Water ret Lt. Brown Remarks
687.8	16	Δ	CONCRETE		Box 4	
686.8	17	Δ	NB. Tight Bond	100%	17.0	Falling Head Test 0.05 in 3 min - 6.7 3/4" Hole
685.8	18		Closed fracture; NB. Shaley Limestone; NB; NB Surface staining (black)		Box 5	
684.8	19		NB; NB Fractured & surface staining; NB Run #6 RQD 79%			
683.8	20		NB			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CWES-D1-80

DRILLING LOG	DIVISION: Detroit	INSTALLATION: Cedars Lock & Dam	SHEET 5 OF 9 SHEETS

1. PROJECT: CEDARS LOCK & DAM
2. LOCATION (Coordinates or Station): SEE BOTTOM OF PAGE #4
3. DRILLING AGENCY: C.E.W.E.S.
4. HOLE NO. (As shown on drawing title and file number): CWES-D1-80
5. NAME OF DRILLER: CLYDE DRAKE
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF ~~overburden~~ Concrete 17.65
8. DEPTH DRILLED INTO ROCK: 2010
9. TOTAL DEPTH OF HOLE: 3~~4~~7.75'
10. SIZE AND TYPE OF BIT: 6x7¾"-DIT-RS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): M.S.L. 5½" X 4" B-782B4RS40P
12. MANUFACTURER'S DESIGNATION OF DRILL: SPRAGE & HENWOOD
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: NINE
15. ELEVATION GROUND WATER: LAKE LEVEL
16. DATE HOLE: STARTED 11 August 80 COMPLETED 12 Aug 80
17. ELEVATION TOP OF HOLE: 703.8
18. TOTAL CORE RECOVERY FOR BORING: 99.3%
19. SIGNATURE OF INSPECTOR:

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
683.8	20		NB — closed; NS			Run #7 WL — Began 9:09 End 10:00 Time 51 min Drl time Hyd press/oc Water press — RPM 75I Drl Action Smooth Water ret Lt. Gray Remarks Run 5.2 Rec 5.2 Loss — Gain —
682.8	21		NB. — weathered & surface staining (BLACK) Solution cavity & xuls of calcite - subhedral & anhedral. NB		Box 5	
681.8	22		NB — enclosed. NB		21.8	
680.8	23		NB. SHALEY LIMESTONE NB.	100%	Box 6	Falling Head Test 6' x 7¾" Hole 1.0' in 30sec 2.0' in 75sec 3.0' in 120sec
679.8	24		NS. Fine to med grnd, gray to Grayish Green in color, moderately hard, dense, fossiliferous, sulfides (Pyrite) and contains numerous interbedded shaley areas - Shale ranges from stringers to 1" beds - Shale is green & competent. Run #7 RQD = 59.6%			
678.8	25		NB NB		Box 6	Run #8 WL Began 10:45 End 11:26 Time 41 min Drl time 41 min Hyd press 100psi Water press — RPM 75I Drl Action Smooth Water ret Gray White Remarks Run 4.9 Rec 4.9 Loss Gain —
677.8	26		NB NB Shaley Limestone		26.2	
676.8	27		FS	100%	Box 7	Falling Head Test. 6x7¾" Hole 1.0' in 20sec 2.0' in 1min
675.8	28		NB			
674.8	29		NB Run #8 RQD = 70.4%			
673.8	30					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — MAR 71 — PROJECT — HOLE NO.

Hole No. CWES-D1-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock & Dam	SHEET 4 OF 4 SHEETS

1. PROJECT: CEDARS LOCK & DAM	10. SIZE AND TYPE OF BIT: 6X 7 3/4" - BIT - RS
2. LOCATION (Coordinates or Station): SEE BOTTOM OF PAGE #4	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): M.S.L. 5 3/8" X 4" B-7828 VRS 80PC 1234
3. DRILLING AGENCY: C.E.N.E.S.	12. MANUFACTURER'S DESIGNATION OF DRILL: SPRAGE & HENWOOD
4. HOLE NO. (As shown on drawing title and file number): CWES-D1-80	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
5. NAME OF DRILLER: CLYDE DRAKE	14. TOTAL NUMBER CORE BOXES: NINE
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: LAKE LEVEL
	16. DATE HOLE: STARTED 11 Aug. 80 COMPLETED 12 Aug 80
7. THICKNESS OF OVERBURDEN: Concrete 17.65	17. ELEVATION TOP OF HOLE: 703.8
8. DEPTH DRILLED INTO ROCK: 20.10	18. TOTAL CORE RECOVERY FOR BORING: 99.3 %
9. TOTAL DEPTH OF HOLE: 37.75'	19. SIGNATURE OF INSPECTOR

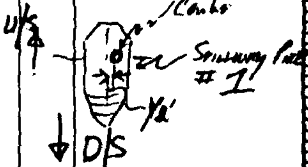
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
673.8	30	NB, NB			30.3	
672.8	31	NB	Shaley Limestone			Run #9 WL — Began 12:01 Run 4.5 End 12:37 Rec 4.5 Time 36 min Loss — Drl time 36 min Gain — Hyd press 100 PSI Water press — RPM 755 Drl Action Smooth Water ret Lt Grey/White Remarks Falling Head Test. 1.0' in 270 sec 2.0' in 64 sec 3.0' in 110 sec
671.8	32			100%	Box 8	
670.8	33	NB, NB, NB				
			Run #9 RQD 83%		33.9	
669.8	34	NB, NB	3PIN			Run #10 WL Began 1:13 Run 3.85 End 2:26 Rec 3.4 Time 77 min Loss 0.4 Drl time 40 min Gain — Hyd press 100 PSI Water press — RPM 755 Drl Action Smooth Water ret Lt Brown Remarks Lost water at 36.0' Core Broke
668.8	35	NB, NB, NB	Shaley LMS		Box 9	
667.8	36			100%		
666.8	37	NB	Run #10 RQD 87%		37.3	
665.8	38					
664.8	39					
663.8	40					

LEGEND

- Concrete
- Limestone
- NB Natural Break
- MB Machine Break
- Fracture

LOCATION

CWES-D1-80



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.

Hole No. C-WES-D2-80

DRILLING LOG	DIVISION: Detroit	INSTALLATION: Cedars Lock & Dam	SHEET 1 of 6 SHEETS
1. PROJECT: Cedars Lock & Dam		10. SIZE AND TYPE OF BIT: 6x7¾" B.F. – RS –	
2. LOCATION (Coordinates or Station): See Page Six –		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL Sheet Br 782841 RS 79 AUG 8	
3. DRILLING AGENCY: CE WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Acker	
4. HOLE NO. (As shown on drawing title and file number): C-WES-D-2-80		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
5. NAME OF DRILLER: C Drake		14. TOTAL NUMBER CORE BOXES: Eleven	
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: —	
		16. DATE HOLE	STARTED: 31 July 80 COMPLETED: 8 August 1980
7. THICKNESS OF ~~OVERBURDEN~~ Concrete 23.95		17. ELEVATION TOP OF HOLE: 706.97	
8. DEPTH DRILLED INTO ROCK: 26.05		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
9. TOTAL DEPTH OF HOLE: 50.0		19. SIGNATURE OF INSPECTOR: Jay B. Dunham	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
706.97	0	Δ	Concrete Grey Brown in color, Contains med sized Natural/Crushed Agg. and Reaction Product visible	100%	Box #1	Run #1 WL — Run 2.2' Began 3:03 Rec 2.2 End 3:57. Loss — Time 54 min Gain — Drl time 49 min Hyd press 250 PSI Water press — RPM 150± Drl Action Smooth Water ret Lt. Brown/White Remarks 6"x7¾" Bbl.
705.97	10	Δ				
704.97	20	Δ	Run #1 RQD=100%			
703.97	30	Δ	Concrete: Same	100%	Box #1	Run # 2 WL — Run 2.35 Began 4:01 Rec 2.35 End 4:51 Loss — Time 50 min Gain — Drl time 45 min Hyd press 250± Water press — RPM 150 Drl Action Smooth Water ret Lt Brown/White Remarks 6"x7¾" Bbl.
702.97	40	Δ				
		Δ	Run #2 RQD=100%		4.55	
701.97	50	Δ	Concrete Same RQD=100%	100%	Box 2	Run #3 WL — Run 4.55 Began 4:58 Rec 4.55 End 5:15 Loss — Time 17 min Gain — Drl time 17 min Hyd press 250± Water press — RPM 150± Drl Action Smooth Water ret Lt Brown/White Remarks 4"x5½" Bbl.
700.97	60	Δ				
699.97	70	Δ				
698.97	80	Δ				
697.97	90	Δ	Run #3		9.1	
696.97	100	Δ	Concrete: Same			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CEDARS D-2-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock & Dam	SHEET 2 OF 6 SHEETS

1. PROJECT: CEDARS LOCK & DAM
2. LOCATION (Coordinates or Station): SEE PAGE SIX
3. DRILLING AGENCY: CE WES
4. HOLE NO. (As shown on drawing title and file number): C-WES-D-2-80
5. NAME OF DRILLER: C. DRAKE
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF ~~OVERBURDEN~~ Concrete 23.95
8. DEPTH DRILLED INTO ROCK: 26.05
9. TOTAL DEPTH OF HOLE: 50.0
10. SIZE AND TYPE OF BIT: 6x7 3/4" BIT — RS —
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL 5 1/2 x 4" BIT 7828 41 RS 79PN 1568
12. MANUFACTURER'S DESIGNATION OF DRILL: ACKER
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: ELEVEN
15. ELEVATION GROUND WATER: —
16. DATE HOLE: STARTED 31 July 80 COMPLETED 8 August 80
17. ELEVATION TOP OF HOLE: 706.97
18. TOTAL CORE RECOVERY FOR BORING: 100 %
19. SIGNATURE OF INSPECTOR:

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
696.97	10				1 Aug 80	Run #4 — Began 7:45, End 8:10, Time 35min; Run 5.0', Rec 5.0', Loss —, Gain —; Drl time 35min; Hyd press 275±; Water press —; RPM 150±; Drl Action Smooth; Water ret Lt. Brown/white; Remarks —
695.97	11					
694.97	12		Concrete. Same	100%	Box 3	
693.97	13					
692.97	14		Run #4 RQD=100%		14.1	
						Run #5 — WL —; Began 8:15, End 9:10, Time 55min; Run 5.05, Rec 5.05, Loss —, Gain —; Drl time 50min; Hyd press 275±; Water press —; RPM 150; Drl Action Smooth; Water ret Lt. Brown/white; Remarks —
691.97	15					
690.97	16		Concrete. Same			
689.97	17		3/4" Re Steel; M.B	100%	Box 4	
688.97	18					
687.97	19		Run #5 RQD=100%		19.15	
686.97	20		Concrete		Box 5	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CEDARS 02-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock 3 Dam.	SHEET 3 OF 6 SHEETS

1. PROJECT: Cedars Lock + Dam
2. LOCATION (Coordinates or Station): SEE PAGE SIL
3. DRILLING AGENCY: CE WES
4. HOLE NO. (As shown on drawing title and file number): C-WES-D-2-80
5. NAME OF DRILLER: C. DRAKE
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF ~~OVERBURDEN~~ Concrete 23.95
8. DEPTH DRILLED INTO ROCK 26.05
9. TOTAL DEPTH OF HOLE 50.0
10. SIZE AND TYPE OF BIT 6x7 3/4" BIT - RS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL 5 1/2 x 4" BIT 782841 RS 79PW1568
12. MANUFACTURER'S DESIGNATION OF DRILL: ACKER
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: Eleven
15. ELEVATION GROUND WATER: —
16. DATE HOLE: STARTED 31 July 80 COMPLETED 8 August 80
17. ELEVATION TOP OF HOLE 706.97
18. TOTAL CORE RECOVERY FOR BORING 100%
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
686.97	20.0		Concrete: Same			Run #6 WL — Began 10:05 End 11:10 Time 65MIN Drl time 55MIN Hyd press 250-350 Water press — RPM 150 Drl Action Smooth Water ret Lt Brown/white Remarks No water loss on Falling Head Test. Run 4.8 Rec 4.8 Loss — Gain —
685.97	21.0				Box 5	
			Closed Hair-line Crack			
684.97	22.0			100%		
683.97	23.0		Loose Bond RQD = 100%			
682.97	24.0		Run #6		23.95	
			MB Limestone	100%	Box 6	Run #7 WL — Began 11:47 End 1:20 Time 93MIN Drl time 30MIN Hyd press 250-300 PSI Water press — RPM 150 Drl Action Smooth Water ret Lt Brown/white Remarks Iron Shavings from B- Steel Tube up Bit Replaced Bit with. Run 1.3 Rec 1.3 Loss — Gain —
681.97	25.0		MB			
			Run #7 RQD: 46.1%			
			RQD = 85.9%			
680.97	26.0		NB Shaley Limestone			
			MB Solution Activity — Pyrite xyls			
679.97	27.0		NB Shale			
			Shaley Lms - Fine to med grnd. Grey in color, Sugary texture and contains	100%	Box 6	
678.97	28.0		MB Shale layers/Beds/Lamina throughout cores length.			
677.97	29.0		MB Breaks are governed by MB these Shaley areas.		29.2	
676.97	30.0		Limestone is also fossiliferous + fairly dense		Box 7	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

Cedars
Hole No. D2-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock and Dam	SHEET 4 OF 6 SHEETS

1. PROJECT Cedars Lock & Dam	10. SIZE AND TYPE OF BIT 6x7 3/4" BIT - RS
2. LOCATION (Coordinates or Station) See Page Six	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) M.S.L. 5 1/2 x 4" BIT 78284 IRS 74PN1568
3. DRILLING AGENCY CE NES	12. MANUFACTURER'S DESIGNATION OF DRILL ACKER
4. HOLE NO. (As shown on drawing title and file number) CWES D-2 80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER C. DRAKE	14. TOTAL NUMBER CORE BOXES Eleven
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER ___
	16. DATE HOLE STARTED 31 July 80 COMPLETED 8 August 1980
7. THICKNESS OF OVERBURDEN Concrete 23.95	17. ELEVATION TOP OF HOLE 706.17
8. DEPTH DRILLED INTO ROCK 26.05	18. TOTAL CORE RECOVERY FOR BORING 100%
9. TOTAL DEPTH OF HOLE 50.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
676.97	30.0		Run #8 MB Shaley LMS			Run #8 WL Began 1:54 Run 4.95 End 2:20 Rec 4.95 Time 26 min Loss — Drl time 26 min Gain — Hyd press 275# Water press — RPM 150± Drl Action Smooth Water ret Lt Brown/white
675.97	31.0					
674.97	32.0		MB MB > SHALE	100%	Box 7	Remarks Falling Head Test 1.0' in 117 sec
673.97	33.0		RQD = 89.6%			Run #9 WL — Began 2:40 Run 4.8' End 3:13 Rec 4.8 Time 33 min Loss — Drl time 33 min Gain — Hyd press 275# Water press — RPM 150± Drl Action Smooth Water ret Lt Brown/white
672.97	34.0		NB → SHALE STAIN NB		33.8 Box 8	
671.97	35.0		Run #9			Remarks Falling Head Test 0.5' in 178 sec
670.97	36.0		NB NB		Box 8	Run 10 WL Began 3:24 Run 4.3 End 3:47 Rec 4.3 Time 23 min Loss — Drl time 23 min Gain — Hyd press 300± Water press — RPM 150± Drl Action Smooth Water ret White Remarks
669.97	37.0		NB Shaley LMS RQD = 93.9%	100%		
668.97	38		NB NB		38.2	
667.97	39.0				Box 9	
666.97	40.0		NB on Mech. Fracture Run 10			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) PROJECT HOLE NO.

Hole No. CEDARS D2-1980

DRILLING LOG	DIVISION Detroit	INSTALLATION CEDARS LOCK & DAM	SHEET 3 OF 6 SHEETS

1. PROJECT: Cedars Lock & Dam
2. LOCATION (Coordinates or Station): SEE PAGE SIX
3. DRILLING AGENCY: CE WES
4. HOLE NO. (As shown on drawing title and file number): C-WES-D-2-80
5. NAME OF DRILLER: C. DRAKE
6. DIRECTION OF HOLE: VERTICAL (checked) / INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Concrete 23.95
8. DEPTH DRILLED INTO ROCK: 26.05
9. TOTAL DEPTH OF HOLE: 50.0
10. SIZE AND TYPE OF BIT: 6 x 7 3/4" BIT — RS —
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): M.S.L. 5 1/2 x 4" BIT 782BW RS 74PW1568
12. MANUFACTURER'S DESIGNATION OF DRILL: ACKER
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: ELEVEN
15. ELEVATION GROUND WATER: —
16. DATE HOLE: STARTED 31 July 80 COMPLETED 8 Aug 80
17. ELEVATION TOP OF HOLE: 706.97
18. TOTAL CORE RECOVERY FOR BORING: 100 %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
666.97	40		NB Shaley LIMESTONE NB RQD=100%	100%	Box 9	Run #11 Run 2.1 Began 4:31 Rec 2.1 End 5:05 Loss — Time 34min Gain — Drl time 34min Hyd press 80-200 L Water press — RPM 100 ± Drl Action Smooth Water ret Lt Brown/White Remarks
665.97	41					
664.97	42		Run 11		42.0	
663.97	43		SHALEY LIMESTONE RQD=100%			Run #12 WL — Run 4.5' Began 10:10 Rec 4.5 End 10:45 Loss — Time 35min Gain — Drl time 35min Hyd press 200 KI Water press — RPM 150 L Drl Action Smooth Water ret Gray/white Remarks
662.97	44			100%	Box 10	
661.97	45		MB			
660.97	46		Run #12		46.5	
659.97	47		NB Shaley Lms RQD=100%			Run #13 WL — Run 3.5' Began 11:01 Rec 3.5 End 11:30 Loss — Time 29min Gain — Drl time 29min Hyd press 200 KI Water press — RPM 150 L Drl Action Smooth Water ret white/Gray Remarks
655.97	48		MB	100%	Box 11	
657.97	49		MB			Hole Took .15' of water (6x7 3/4" hole) in 2 minutes
656.97	50		Run #13			

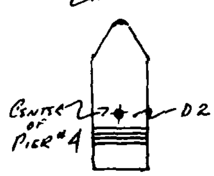
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) PROJECT HOLE NO.

Hole No. CEDARS C-D2-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock 3 Dam	SHEET 2 OF 6 SHEETS

1. PROJECT Cedars Lock + Dam	10. SIZE AND TYPE OF BIT 6x7 3/4" BIT — RS —
2. LOCATION (Coordinates or Station) SEE PAGE SIX —	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) M.S.L. 5 1/2 x 4" BIT 782B41RS 74PMIS48
3. DRILLING AGENCY CE WES	12. MANUFACTURER'S DESIGNATION OF DRILL ACKER
4. HOLE NO. (As shown on drawing title and file number) C-WES-D-2-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED —
5. NAME OF DRILLER C. DRAKE	14. TOTAL NUMBER CORE BOXES Eleven
	15. ELEVATION GROUND WATER —
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED 31 July 80 — COMPLETED 8 Aug 80
7. THICKNESS OF ~~OVERBURDEN~~ Concrete 23.95	17. ELEVATION TOP OF HOLE 706.97
8. DEPTH DRILLED INTO ROCK 26.05	18. TOTAL CORE RECOVERY FOR BORING 100 %
9. TOTAL DEPTH OF HOLE 50.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			LEGEND CONCRETE LIMESTONE NB NATURAL BREAK MB MACHINE BREAK LOCATION			



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CWES-D3-80

DRILLING LOG	DIVISION: Detroit	INSTALLATION: Cedars Lock & Dam	SHEET 1 OF 5 SHEETS

1. PROJECT: Cedars Lock & Dam	10. SIZE AND TYPE OF BIT: 6 x 7¾ BS — B.T —
2. LOCATION (Coordinates or Station): See Page 5	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): HSL 5½ x 4" 21A52
3. DRILLING AGENCY: CWES	12. MANUFACTURER'S DESIGNATION OF DRILL: Acker
4. HOLE NO. (As shown on drawing title and file number): CWES-D3-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
5. NAME OF DRILLER: Clyde Drake	14. TOTAL NUMBER CORE BOXES: Nine
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Pool Level
	16. DATE HOLE: STARTED 8 Aug 80; COMPLETED 13 Aug 1980
7. THICKNESS OF [redacted]: Concrete: 17.2'	17. ELEVATION TOP OF HOLE: 703.8
8. DEPTH DRILLED INTO ROCK: 21.85	18. TOTAL CORE RECOVERY FOR BORING: 99.0 %
9. TOTAL DEPTH OF HOLE: 39.05	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
703.8	0	Δ	Concrete: Grey Brown in color, Natural Aggregate, Size from 1/8 to 3/4" with Avg at 1/2". Some Reaction Product Visible			Run #1 8 Aug 80; WL —; Began 4:30–5:01; End 7:30–8:20; Time 81 min; Drl time 20 min; Run 1.55'; Rec 1.55'; Loss —; Gain —; Hyd press 200 PSI ±; Water press —; RPM 75±; Drl Action Smooth; Water ret Lt Brown/white; Remarks 6" x 7¾" Bbl.
702.8	1	Δ		100%	Box 1	
		Δ	Run #1 RQD = 100%			
701.8	2	Δ			Box 1	
700.8	3	Δ	Concrete:		3.45	Run #2 8 Aug 80; WL —; Began 8:35; End 9:05; Time 30 min; Drl time 30 min; Run 4.7'; Rec 4.7; Loss —; Gain —; Hyd press 250±; Water press —; RPM 75±; Drl Action Smooth; Water ret Lt Brown/white; Remarks
			MB			
699.8	4	Δ		100%	Box 2	
698.8	5	Δ				
			MB			
697.8	6	Δ	Run #2 RQD = 100%			
696.8	7	Δ	Concrete:		Box 2	Run #3; WL —; Began 9:37; End 10:05; Time 28 min; Drl time 25 min; Run 4.9; Rec 4.9; Loss —; Gain —; Hyd press 200 PSI; Water press —; RPM 75–100; Drl Action Smooth; Water ret Lt Brown/white; Remarks
695.8	8	Δ		100%	8.1	
694.8	9	Δ			Box 3	
693.8	10	Δ				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CNES-03-80

DRILLING LOG	DIVISION Detroit	INSTALLATION CEDARS Lock + Dam	SHEET 2 OF 5 SHEETS

1. PROJECT: CEDARS Lock + Dam	10. SIZE AND TYPE OF BIT: BIT 21AS2
2. LOCATION (Coordinates or Station): See Page 5	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL 5½x4" RS80PC1234 - BIT 782841
3. DRILLING AGENCY: CEWES	12. MANUFACTURER'S DESIGNATION OF DRILL: Acker
4. HOLE NO. (As shown on drawing title and file number): CNES-03-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: CLYDE DRAKE	14. TOTAL NUMBER CORE BOXES: N.NC
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Pool Level
7. THICKNESS OF ~~OVERBURDEN~~ Concrete 17.2'	16. DATE HOLE: STARTED 6 Aug 80, COMPLETED 13 Aug 80
8. DEPTH DRILLED INTO ROCK: 21.85	17. ELEVATION TOP OF HOLE: 703.8
9. TOTAL DEPTH OF HOLE: 39.05	18. TOTAL CORE RECOVERY FOR BORING: 99.0%
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
693.8	10					
692.8	11		Run #3 RQD=100%		Box 3	
691.8	12		Concrete			Run #4 WL — Began 10:19 End 11:00 Time 41min Drl time 30min Hyd press 200 Water press — RPM 100± Drl Action Smooth Water ret Lt. Brown/white Remarks Run 4.55 Rec 4.55 Loss — Gain —
690.8	13			100%	Box 4	
689.8	14					
688.8	15		MB.			
			Run #4 RQD=100%		15.75	
687.8	16		¾" Re-Steel Concrete			Run #5 WL — Began 11:14 End 11:55 Time 41min Drl time 30min Hyd press 200± Water press — RPM 100± Drl Action Smooth Water ret Lt Brown/Grey Remarks Run 4.65 Rec 4.65 Loss -- Gain —
686.8	17		Tight Bond NB Closed		Box 5	
685.8	18		Shaley Limestone NB Closed	100%		Falling Head Test 6x7¾" Hole Fell 10' in 20sec
684.8	19		NB. Surface Staining (Black) NB NB Closed NB Open Verticle Feature From 19.1 to 20.1 ft. Staining Along Break Surface			
683.8	20					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) PROJECT HOLE NO.

Hole No. CWES-D3-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock & Dam	SHEET 3 OF 5 SHEETS

1. PROJECT: Cedars Lock & Dam	10. SIZE AND TYPE OF BIT: 6x7¾ R3-BIT
2. LOCATION (Coordinates or Station): See Page 5	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL. 5⅞x4 RS40M 1134-BIT 782841
3. DRILLING AGENCY: CEWES	12. MANUFACTURER'S DESIGNATION OF DRILL: Acker
4. HOLE NO. (As shown on drawing title and file number): CWES-D3-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: Clyde Drake	14. TOTAL NUMBER CORE BOXES: Nine
6. DIRECTION OF HOLE: VERTICAL / INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Pool Level
	16. DATE HOLE: STARTED 12 Aug 1980, COMPLETED 13 Aug 1980
7. THICKNESS OF ~~OVERBURDEN~~ Concrete: 17.2'	17. ELEVATION TOP OF HOLE: 703.8
8. DEPTH DRILLED INTO ROCK: 21.55	18. TOTAL CORE RECOVERY FOR BORING: 99.07 %
9. TOTAL DEPTH OF HOLE: 39.05	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
683.8	20.0		NB; NB			
			Run #5 RQD= 69.1%		20.6	Run #6
682.8	21.0		NB. Limestone LM			WL 100%; Began 1 40; End 2 30; Time; Drl time; Hyd press 200±; Water press —; RPM 100±; Drl Action Smooth; Water ret Milky White/Grey; Run 2.95; Rec 2.95; Loss —; Gain —
			NB			
			NB; NB — surface staining		Box 6	
681.8	22.0		Water Loss	100%		
			NB; NB — surface staining			
			NB			Lost water circulation at 22.5 ft
680.8	23.0		NB			
			Run #6 RQD= 45.8%			Grouted Hole. Approx. 8 gallons water 360 lbs Portland Cement 12 ft Jack Coll.
679.8	24.0		NB. Limestone LM	100%	Box 6	
			Run #7 RQD=100%		24.5	Regrouted — Same except Approx 24 ft Jack Coll.
678.8	25.0		NB			Run #7; Began 7 30; End 8 40; Time 70min; Drl time 40min; Hyd press 200±; Water press — 75±; Drl Action Smooth; Water ret Grey; Run —; Rec 95; Loss —; Gain —
			NB			
677.8	26.0					Remarks: Drilled Grout From Above Headtest — 0.2/5min
			NB		Box 7	
676.8	27.0		N.B. Limestone LM	100%		
675.8	28.0					WL Run #8; Began 8 50; End 9 30; Time 40min; Drl time 40min; Hyd press 200±; Water press —; RPM 100±; Drl Action Smooth; Water ret Lt Grey/White; Run 5.0; Rec 5.0; Loss —; Gain —
			NB			
674.8	29.0		Run #8 RQD= 93.0%		29.5	
673.8	30.0					Remarks — Falling Head Test 0.05/min

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CWES-D3-80

DRILLING LOG	DIVISION Detroit	INSTALLATION CEDARS Lock + Dam	SHEET 4 OF 5 SHEETS
1. PROJECT CEDARS Lock + DAM		10. SIZE AND TYPE OF BIT 6 7/8" RS — BIT	
2. LOCATION (Coordinates or Station) See Page 5		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) M.S.L. 5 1/2 x 4" RS 8 APC 1234 - BIT 21AS2	
3. DRILLING AGENCY CEWES		12. MANUFACTURER'S DESIGNATION OF DRILL Acker	
4. HOLE NO. (As shown on drawing title and file number) CWES - D3-80		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED — UNDISTURBED —
5. NAME OF DRILLER Clyde Drake		14. TOTAL NUMBER CORE BOXES Nine	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER Pool Level	
7. THICKNESS OF ~~OVERBURDEN~~ Concrete: 17.2'		16. DATE HOLE STARTED 8 Aug 80 COMPLETED 13 Aug 80	
8. DEPTH DRILLED INTO ROCK 21.85		17. ELEVATION TOP OF HOLE 703.8	
9. TOTAL DEPTH OF HOLE 39.05		18. TOTAL CORE RECOVERY FOR BORING 99.0%	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
673.8	30		NB			Run #9
672.8	31		NB SHALEY LIMESTONE LH			WL — Run 4.9' Rec 4.9' Began 9:52 End 10:33 Loss — Gain — Time 41 min Drl time 41 min Hyd press 200 PSI Water press — RPM 200±
671.8	32		NB	100%	Box 8	Drl Action Smooth Water ret Lt Grey/white
670.8	33		NB			Remarks Falling Head Test 0.35' in 1.5 min
669.8	34		NB Run #9 RQD=100%		34.4	
668.8	35		3/8" SHALE - Reddish Stain			Run #10 WL — Run 4.65 Rec 4.75 Began 10:57 End 11:30 Loss .10 Gain — Time 33 min Drl time 33 min Hyd press 200 PSI
667.8	36		NB SHALEY LIMESTONE LH		Box 9	Water press — RPM 100± Drl Action Smooth Water ret Lt Grey/white
666.8	37			91%		Remarks Falling Head Test 1.10' in 1 min LH
665.8	38					Hole Depth 39.05 Core to 38.6'
			NB Run #10 RQD 82.5%		38.6	
664.8	39		Left in hole LH			
663.8	40					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No.

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock & Dam	SHEET 5 OF 5 SHEETS

1. PROJECT Cedars Lock & Dam	10. SIZE AND TYPE OF BIT NX 7⅝ RS BIT
2. LOCATION (Coordinates or Station) See Page 5	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL [illegible] RS 8 [illegible]
3. DRILLING AGENCY CENCS	12. MANUFACTURER'S DESIGNATION OF DRILL Acker
4. HOLE NO. (As shown on drawing title and file number) CNCS 03 80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED: — UNDISTURBED: —
5. NAME OF DRILLER Clyde Drake	14. TOTAL NUMBER CORE BOXES None
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER Pool Level
	16. DATE HOLE — STARTED 8 Aug 80 — COMPLETED 13 Aug 80
7. THICKNESS OF OVERBURDEN Concrete: 17.2'	17. ELEVATION TOP OF HOLE 703.8
8. DEPTH DRILLED INTO ROCK 21.85	18. TOTAL CORE RECOVERY FOR BORING 98 %
9. TOTAL DEPTH OF HOLE 39.05	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g

CNCS-03-80
5 of 5

LEGEND

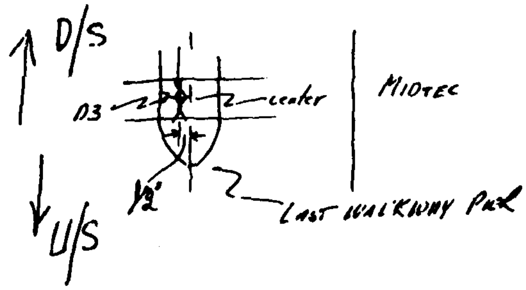
[Δ] CONCRETE

[≡] LIMESTONE

MB MACHINE BREAK

NB NATURAL BREAK

LOCATION - CEDARS LOCK & DAM



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CWES-D4-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock + Dam	SHEET 1 OF SHEETS

1. PROJECT: Cedars Lock and Dam	10. SIZE AND TYPE OF BIT: 6 x 7 3/4
2. LOCATION (Coordinates or Station): See Page Three	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): Upper Pool (MSL) 5 7/8 x 4" Z1ASE
3. DRILLING AGENCY: CEWES	12. MANUFACTURER'S DESIGNATION OF DRILL: S+H
4. HOLE NO. (As shown on drawing title and file number): CWES-D4-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
5. NAME OF DRILLER: Clyde Drake	14. TOTAL NUMBER CORE BOXES: Five
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Upper Pool
7. THICKNESS OF [redacted] WATER: 0.1	16. DATE HOLE: STARTED 15 August 80; COMPLETED 16 August 80
8. DEPTH DRILLED INTO ROCK: 21.75'	17. ELEVATION TOP OF HOLE: 687.1
9. TOTAL DEPTH OF HOLE: 21.75'	18. TOTAL CORE RECOVERY FOR BORING: 98%
	19. SIGNATURE OF INSPECTOR: Joseph B. Dunbar

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
687.1	0		NB Run #1		Box 1	Run #1 WL — Begin 4:30 End 5:00 Time 30 min Run 0.5' Rec 0.5' Loss — Gain — 30 min 50 to 100 PSI Press — 35% Action Smooth Water ret Remarks 6" x 7 3/4" Bbl to make room for 8" Cs
686.1	1		NB, NB, NB, NB			
685.1	2		NB Shaley Lms, NB			
684.1	3		NB, NB weathered	100%	Box 1	
683.1	4		NB, NB, NB, NB			Run #2 WL — Begin 3:25 End 4:02 Time 37 min Run 4.7' Rec 4.7' Loss — Gain — 35 min 100 PSI Press — 75% Action Smooth Water ret Remarks
682.1	5		NB spin Run #2 RQD = 36%		49	
681.1	6		NB			
680.1	7		NB Shaley Limestone. Fine to med grained, grey to greenish gray in color, moderately hard, dense, and contains numerous seams, lenses, beds, lamina, of interbedded shales (Green in color). Limestone is also fossiliferous.	100%	Box 2	Run #3 9:20 10:30 Run 4.2' Rec 4.2' Loss — Gain — 50 min 50 min 100 Press — 75% Action Smooth Water ret Remarks
679.1	8		NB			
678.1	9		NB, NB Run #3 RQD = 75%		94	
677.1	10					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) PROJECT HOLE NO.

Hole No. CWES-D4-80

DRILLING LOG	DIVISION	INSTALLATION Cedars Lock + Dam	SHEET 2 OF 3 SHEETS
1. PROJECT Cedars Lock and Dam		10. SIZE AND TYPE OF BIT 6 x 7 3/4	
2. LOCATION (Coordinates or Station) See Page Three		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) Upper Pool (MSL) 5 3/4" ...	
3. DRILLING AGENCY CEWES		12. MANUFACTURER'S DESIGNATION OF DRILL S+H	
4. HOLE NO. (As shown on drawing title and file number) CWES-D4-80		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER Clyde Drake		14. TOTAL NUMBER CORE BOXES Five	
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER Upper Pool	
		16. DATE HOLE STARTED 15 Aug 1980 COMPLETED 16 Aug 1980	
7. THICKNESS OF OVERBURDEN Water 12.1		17. ELEVATION TOP OF HOLE 687.1	
8. DEPTH DRILLED INTO ROCK 21.75'		18. TOTAL CORE RECOVERY FOR BORING 98 %	
9. TOTAL DEPTH OF HOLE 21.75'		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
677.1	10		NB			
676.1	11		NB Shaley Limestone	100%		Run #4 WL — 4.55' 10:50 4.55 11:37 Loss — 47min Gain — 45min 100±
675.1	12		NB		Box 3	75± Smooth
			NB			
674.1	13		NB			
673.1	14		Run #4 RQD = 92.3% ← Spin		13.95	
			NB NB			
672.1	15				Box 4	Run #5 4.35 12.40 4.35 1:08 28min 27min 100PSI
			NB Shaley Limestone			
671.1	16			100		75± Smooth
			NB			
670.1	17					
			NB			Run #6 WL — Run 3.35
669.1	18		Run #5 RQD 97.7%		18.2	1.35 Rec 7.0 2:01 Loss 0.5 26min Gain — 26min 100PSI
668.1	19		Shaley Limestone	84.5%	Box #5	75± Smooth
			NB			Remarks
667.1	20					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CWES-D4-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock + Dam	SHEET 3 OF 3 SHEETS

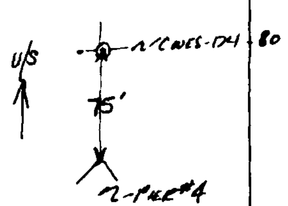
1. PROJECT Cedars Lock and Dam	10. SIZE AND TYPE OF BIT 6 x 7 3/4
2. LOCATION (Coordinates or Station) See Page Three	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) UPPER POOL (MSL) 5 1/2 x 4 1/2" BIT 21AE2 CS-MK 1234
3. DRILLING AGENCY CEWES	12. MANUFACTURER'S DESIGNATION OF DRILL S & H
4. HOLE NO. (As shown on drawing title and file number) CWES-D4-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER CLYDE Drake	14. TOTAL NUMBER CORE BOXES Five
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER UPPER POOL
7. THICKNESS OF ~~OVERBURDEN~~ water 15.1	16. DATE HOLE — STARTED 15 Aug 80 — COMPLETED 16 Aug 80
8. DEPTH DRILLED INTO ROCK 21.75'	17. ELEVATION TOP OF HOLE 687.1
9. TOTAL DEPTH OF HOLE 21.75'	18. TOTAL CORE RECOVERY FOR BORING 98 %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
667.1	20				Box 5	
666.1	21		Run #6 RQD=100%			
			Left in hole			

LEGEND

- Limestone
- Concrete
- MB = Machine Break
- NB = Natural Break

LOCATION



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CWES-DS-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock + Dam	SHEET 1 OF 3 SHEETS

1. PROJECT: Cedars Lock 3 Dam
2. LOCATION (Coordinates or Station): 41 FT From Pier #4. D/S and on center line
3. DRILLING AGENCY: C.E.N.E.S.
4. HOLE NO. (As shown on drawing title and file number): CWES-DS-80
5. NAME OF DRILLER: Clyde Drake
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Water 6.7'
8. DEPTH DRILLED INTO ROCK: Lais 21.2'
9. TOTAL DEPTH OF HOLE:
10. SIZE AND TYPE OF BIT: 5 1/2 x 4" 21A52-
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): Bit 71K655
12. MANUFACTURER'S DESIGNATION OF DRILL: S.H
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES: Five
15. ELEVATION GROUND WATER: Lower Pool
16. DATE HOLE: STARTED 8/20/80 COMPLETED 8/22/80
17. ELEVATION TOP OF HOLE: 683.41
18. TOTAL CORE RECOVERY FOR BORING: 100 %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
683.41	0.0		scoured; NB; NB			
682.41	1.0		NB - weathered			Run #1 Aug 20/80 WL — Run 4.4' Began 12:30 Rec 4.4' End 1:30 Loss — Time 60 min Gain — Drl time Comm Hyd press 100psi Water press — RPM 75± Drl Action Smooth Water ret Remarks
681.41	2.0		LIMESTONE. NB NB Fine to med grained, moderately hard, dense NB fossiliferous, grey to greish green in color with shale lenses, lamina, seams, etc through core's length. Shaley regions govern core breaks.	100%	Box 1	
680.41	3.0		NB			
679.41	4.0		NB; Mech (fractured) Run #1 RQD=61.9%		4.4'	
678.41	5.0		LIMESTONE			Run #2 Aug 21/80 WL Run 2.8 Began 1:30 Rec 2.8 End 2:20 Loss — Time Gain — 50 min Drl time 100psi Water press — RPM 50-70± Drl Action Smooth Water ret Remarks
677.41	6.0		NB; NB	100%	Box 2	
676.41	7.0		Run #2 RQD=100%			
675.41	8.0		NB LIMESTONE			Run #3 WL Run 4.1 Began 2:41 Rec 3.75 End 4:30 Loss — Time 109 min Gain — Drl time 31 min Hyd press 100psi Water press — RPM 70± Drl Action Smooth Water ret Remarks Dropped Lost 0.35
674.41	9.0		NB	91.5%	Box 2	
673.41	10.0				9.4	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CWES-DS-80

DRILLING LOG	DIVISION: Detroit	INSTALLATION: Cedars Lock + Dam	SHEET 2 OF 3 SHEETS

1. PROJECT: CEDARS LOCK + DAM	10. SIZE AND TYPE OF BIT: 5½ X 4 7/8 INS2-80PL1238
2. LOCATION (Coordinates or Station): 41 Ft From Pier #4, D/S and on center line.	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): BTT 79PK655
3. DRILLING AGENCY: C.E.N.E.S.	12. MANUFACTURER'S DESIGNATION OF DRILL: S.H
4. HOLE NO. (As shown on drawing title and file number): CWES-DS-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
5. NAME OF DRILLER: CLYDE DRAKE	14. TOTAL NUMBER CORE BOXES: Five
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Lower Pool
7. THICKNESS OF OVERBURDEN: Water 6.7'	16. DATE HOLE: STARTED 8/20/80 COMPLETED 8/22/80
8. DEPTH DRILLED INTO ROCK: Lms. 21.2'	17. ELEVATION TOP OF HOLE: 663.41
9. TOTAL DEPTH OF HOLE: —	18. TOTAL CORE RECOVERY FOR BORING: 100 %
	19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
673.41	10		RQD=91.2%		Box 3	
			DROPPED LAST 0.35 into River			
672.41	11		RUN #3 NO CORE			
						RUN #4 Began 4:30 Run 5.1 End 5:15 Rec 5.1 Time 45min Loss — Drl time 40min Gain — Hyd press 100PSI Water press — RPM 75± Drl Action Smooth Water ret / Remarks /
671.41	12	NB			Box 3	
670.41	13	NB	LIMESTONE			
669.41	14	NB				
		NB			14.45	
668.41	15	NB NB NB			Box 4	Aug 22/80 RUN #5
667.41	16		RUN #4 RQD=88.2%			Began 7:45 Run 4.75 End 8:15 Rec 4.75 Time 30MIN Loss — Drl time 30MIN Gain — Hyd press 100PSI Water press — RPM 75± Drl Action Smooth Water ret / Remarks /
666.41	17	NB				
665.41	18	NB	Limestone.		17.95	
664.41	19				Box 5	
		NB				
663.41	20					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

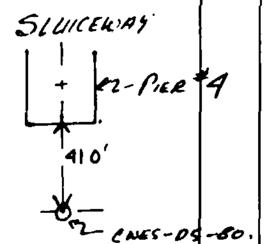
Hole No. CNES-DS-80

DRILLING LOG	DIVISION: Detroit	INSTALLATION: Cedars Lock + Dam	SHEET 3 OF 3 SHEETS

1. PROJECT: Cedars Lock + Dam	10. SIZE AND TYPE OF BIT: 5 1/2 x 4" 2, AS2 - Super 1234
2. LOCATION (Coordinates or Station): 41 Ft. From Pier #4 D/S Along Center Line	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): BJT 79M655
3. DRILLING AGENCY: CENES	12. MANUFACTURER'S DESIGNATION OF DRILL: SH
4. HOLE NO. (As shown on drawing title and file number): CNES-DS-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED: — UNDISTURBED: —
5. NAME OF DRILLER: Clyde Drake	14. TOTAL NUMBER CORE BOXES: Five
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Lower Pool
	16. DATE HOLE — STARTED: 8/20/80 — COMPLETED: 8/22/80
7. THICKNESS OF ~~OVERBURDEN~~ Water 6.7'	17. ELEVATION TOP OF HOLE: 683.41
8. DEPTH DRILLED INTO ROCK: LMS. 21.2'	18. TOTAL CORE RECOVERY FOR BORING: 100 %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
663.41	20				Box 5	
662.41	21		Run #5 RQD-100%			
			End			

Location



Legend

Limestone
NB Natural Break
MB. Machine Break

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CWES-D6-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock + Dam	SHEET 1 OF 1 SHEETS
1. PROJECT Cedars Lock + Dam		10. SIZE AND TYPE OF BIT 5 1/2" x 4"	
2. LOCATION (Coordinates or Station) See Below		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) Lower Pool - MSL	
3. DRILLING AGENCY C.E. W.E.S.		12. MANUFACTURER'S DESIGNATION OF DRILL Sprague + Henwood	
4. HOLE NO. (As shown on drawing title and file number) CWES-D6-80		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER Clyde Drake		14. TOTAL NUMBER CORE BOXES One	
6. DIRECTION OF HOLE X VERTICAL ☐ INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER Lower Pool - 689.91	
		16. DATE HOLE STARTED 19 August 80 COMPLETED 19 August 80	
7. THICKNESS OF Concrete 1.45		17. ELEVATION TOP OF HOLE 689.91	
8. DEPTH DRILLED INTO ROCK 3.35		18. TOTAL CORE RECOVERY FOR BORING 100%	
9. TOTAL DEPTH OF HOLE 4.8		19. SIGNATURE OF INSPECTOR [signature]	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
686.91	0		1" Re-steel Concrete: Natural Aggregate (Size, 1/8" to 3/4") Reaction Product Visible (slight)			Run #1 #L — Run 4.8' Began 2 35 Rec 4.8' End 3 38 Loss — Time 63 min Gain — Dri time 60 min Hyd press 50-100 PSI Water press — RPM 20 To 100 ± Dri Action Smooth Water ret
685.91	1		NB			
684.91	2		NB Shaley Limestone NB	100%	Box #1	Remarks
683.91	3		NB			
682.91	4		NB NB NB NB			
			Run #1 RQD=83%		4.8'	
681.91	5					
680.91	6					
679.91	7					

Legend
[concrete symbol] Concrete
[limestone symbol] Limestone
NB = Natural Break

Location: Cedars Lock + Dam

CWES-D6-80

Lock No. 4

1.68 / 1.8

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT | HOLE NO.

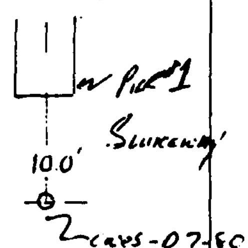
Hole No. CAES-D7-80

DRILLING LOG	DIVISION: DETROIT	INSTALLATION: CEDARS LOCK + DAM	SHEET 1 OF 1 SHEETS

1. PROJECT: CEDARS LOCK 3 DAM
2. LOCATION (Coordinates or Station): SEE BELOW
3. DRILLING AGENCY: CEWES
4. HOLE NO. (As shown on drawing title and file number): CWES-D7-80
5. NAME OF DRILLER: CLYDE DRAKE
6. DIRECTION OF HOLE: X VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF [redacted] WATER 4.1
8. DEPTH DRILLED INTO ROCK: 6.2
9. TOTAL DEPTH OF HOLE: 6.2
10. SIZE AND TYPE OF BIT: 5½ x 4" BS ... ; BIT 79PK6
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: SPRAGUE + HENWOOD
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: TWO
15. ELEVATION GROUND WATER: LOWER POOL
16. DATE HOLE: STARTED 23 AUGUST 80; COMPLETED 23 AUGUST 80
17. ELEVATION TOP OF HOLE: 690.01
18. TOTAL CORE RECOVERY FOR BORING: 100 %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
685.91	0.0	MB, MB				Run #1
684.91	1.0		LIMESTONE	100%	Box #1	Run 3.55; Rec 3.55; Loss —; Gain —; Begin 10:43; End 11:45; Time 62 min; Drill time 60 min; Pump press 100 PSI; Water press —; RPM 85-70±; Drill Action Smooth; Water ret /; Remarks: BLOCKED OFF
683.91	2.0		NON-weathered			
682.91	3.0	MB, MB, MB	Run #1 RQD = 66.2%		3.55	
681.91	4.0	MB, MB				Run #2
680.91	5.0	MB	LIMESTONE	100%	Box 2	Run 2.6; Rec 2.6; Loss —; Gain —; Began 1:15; End 1:35; Time 20 min; Drill time 20 min; Pump press 100 PSI; Water press —; RPM 70±; Drill Action Smooth; Water ret /; Remarks /
679.91	6.0	MB	Run #2 RQD - 73.1%		6.2	

LOCATION



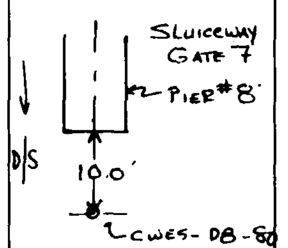
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. CWES-DB-80

DRILLING LOG	DIVISION: DETROIT	INSTALLATION: Cedars Lock + Dam	SHEET 1 OF 1 SHEETS
1. PROJECT: Cedars Lock + Dam		10. SIZE AND TYPE OF BIT: 6 1/2 x 4" NX L55-Bit	
2. LOCATION (Coordinates or Station): See below		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL BS 80R1234	
3. DRILLING AGENCY: CEWES		12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague + Henwood	
4. HOLE NO. (As shown on drawing title and file number): CWES-DB-80		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —	
5. NAME OF DRILLER: CLYDE DRAKE		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: Lower Pool	
7. THICKNESS OF ~~OVERBURDEN~~ Water 3.75'		16. DATE HOLE: STARTED 22 August 80 COMPLETED 22 August 80	
8. DEPTH DRILLED INTO ROCK: 5.2		17. ELEVATION TOP OF HOLE: 690.01	
9. TOTAL DEPTH OF HOLE: 5.2'		18. TOTAL CORE RECOVERY FOR BORING: 87.5 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
686.26	0.0		scoured; NB			
			NB			Run #1
685.26	1.0		NB; NB			WL — Run 5.2 Began 1:35 Rec 4.55 End 2:15 Loss .65 Time 40min Gain — Drl time 40min Hyd press 100PSI Water press — RPM 70± Drl Action Smooth Water ret —
			Limestone		Box 1	
684.26	2.0		NB. Fine to med grained, grey to greenish grey in color, med. hard, dense, fossiliferous, + contains numerous shale seams, lenses, lamina etc. – Shaley [illegible]s regions control core breaks	87.5%		
			NB			Remarks —
683.26	3.0					
			NB; NB			
682.26	4.0		NB			
			NB		4.55	
681.26	5.0		1 left in hole Run #1 RQD: 57.7%			

Location



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT | HOLE NO.

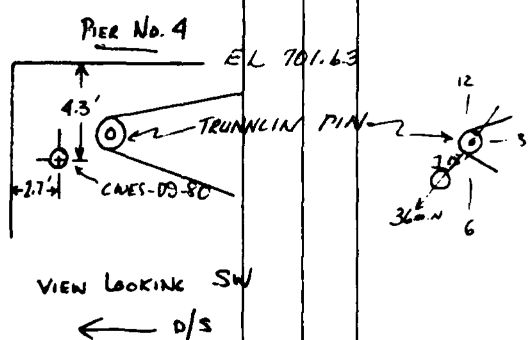
Hole No. CWES-D9-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock + Dam	SHEET 1 OF 1 SHEETS

1. PROJECT Cedars Lock + Dam	10. SIZE AND TYPE OF BIT 6¼ x 6" 79AW0435
2. LOCATION (Coordinates or Station) See Below	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY CEWES	12. MANUFACTURER'S DESIGNATION OF DRILL Electric
4. HOLE NO. (As shown on drawing title and file number) CWES-D9-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED —
5. NAME OF DRILLER Clyde Drake	14. TOTAL NUMBER CORE BOXES One
6. DIRECTION OF HOLE ☐ VERTICAL ☒ INCLINED 90° DEG. FROM VERT.	15. ELEVATION GROUND WATER Lower Pool
	16. DATE HOLE STARTED 22 August 80 COMPLETED 22 August 80
7. THICKNESS OF ~~OVERBURDEN~~ Concrete 2.85'	17. ELEVATION TOP OF HOLE 697.33
8. DEPTH DRILLED INTO ROCK 2.85'	18. TOTAL CORE RECOVERY FOR BORING 100%
9. TOTAL DEPTH OF HOLE 2.85'	19. SIGNATURE OF INSPECTOR [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
697.33	0.0	Δ	Concrete Natural Aggregate, Reaction Product visible, and Slightly porous.	100%	Box 1	Run #1 WL — P 2.85 Began 11.30 R. 2.85 End 11.55 L — Time 25 min G — Drl time 2 min Hyd press — Water press — RPM 150 T Drl Action Smooth Water ret Lt Brown/Wht Remarks
	2.85		Run #1 RQD=100%			

Location



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) PROJECT HOLE NO.

Hole No. CWES-D10-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock + Dam	SHEET 1 OF 1 SHEETS

1. PROJECT Cedars Lock 3 Dam	10. SIZE AND TYPE OF BIT 2¾x6" 79PN 64/35
2. LOCATION (Coordinates or Station) See Bottom of Page	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL.
3. DRILLING AGENCY C.E.W.E.S	12. MANUFACTURER'S DESIGNATION OF DRILL Clark Rig
4. HOLE NO. (As shown on drawing title and file number) CWES-D10-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED —
5. NAME OF DRILLER Clyde Drake	14. TOTAL NUMBER CORE BOXES ONE
6. DIRECTION OF HOLE ☐ VERTICAL ☑ INCLINED 90° DEG. FROM VERT.	15. ELEVATION GROUND WATER —
	16. DATE HOLE STARTED 18 August 80 COMPLETED 18 August 80
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE 696.3'
8. DEPTH DRILLED INTO ROCK 3.15'	18. TOTAL CORE RECOVERY FOR BORING 96.5 %
9. TOTAL DEPTH OF HOLE 3.15'	19. SIGNATURE OF INSPECTOR [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
696.3	0.0	Δ				
696.3	1.0	Δ	0.15 Concrete. Crushed Aggregate with size from sand to several lrg. pieces 2"x2". Fill material is primarily igneous in nature			WL — Run 3.15 Began 2:30 Rec 2.85 End 3:10 Loss 0.30 Time 40 min Gain — Drl time 3 min
696.3	2.0	Δ		96.5%	Box #1	Hyd press — Water press — RPM 150 Drl Action Smooth Water ret Lt Gray/Brown Remarks
		Δ	Run #1 RQD=100%			
696.3	3.0		Lost			

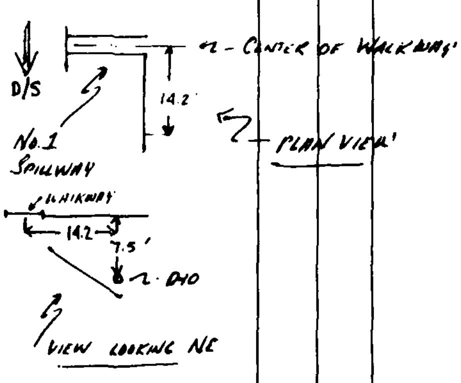
LEGEND

[Δ] Concrete

MB Machine Break.

LOCATION

CH



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) PROJECT HOLE NO.

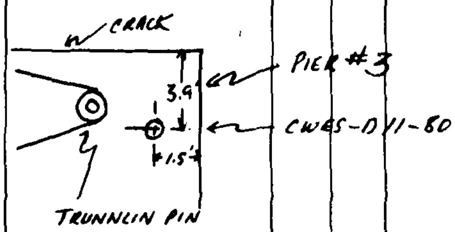
Hole No. CWES-D11-80

DRILLING LOG	DIVISION Detroit	INSTALLATION Cedars Lock & Dam	SHEET 1 OF 1 SHEETS

1. PROJECT Cedars Lock & Dam	10. SIZE AND TYPE OF BIT 1 7/8 "
2. LOCATION (Coordinates or Station) See Below	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY WES	12. MANUFACTURER'S DESIGNATION OF DRILL Electric
4. HOLE NO. (As shown on drawing title and file number) CWES-D11-80	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED —
5. NAME OF DRILLER Clyde Drake	14. TOTAL NUMBER CORE BOXES One
6. DIRECTION OF HOLE — VERTICAL, INCLINED 90° DEG. FROM VERT.	15. ELEVATION GROUND WATER —
	16. DATE HOLE STARTED 22 Aug 80 COMPLETED 22 Aug 80
7. THICKNESS OF OVERBURDEN Concrete 29.5	17. ELEVATION TOP OF HOLE 699.73
8. DEPTH DRILLED INTO ROCK 29.5'	18. TOTAL CORE RECOVERY FOR BORING 100 %
9. TOTAL DEPTH OF HOLE 29.5'	19. SIGNATURE OF INSPECTOR Joseph B. Dunbar

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
699.73	0.0		Closed fracture			Run #1
	10		Concrete	100%	Box 1	Run 29.5' Rec 29.5' Loss — Gain —
	20	NB NB NB NB				Time 9:57 – 10:16; Manual; press —; press —; 150; Action Smooth; Water ret: Brown/white; Remarks
	30		Run #1			

LOCATION



VIEW LOOKING NE

D/S →

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) PROJECT HOLE NO.

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Stowe, Richard L.
Condition survey of Cedars Lock and Dam Lower Fox River, Wisconsin / by Richard L. Stowe, Joyce C. Ahlvin (Structures Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. : available from NTIS, 1982.
89 p. in various pagings, 26 p. of plates ; ill. ; 27 cm. -- (Miscellaneous paper ; SL-82-4)
Cover title.
"June 1982."
Final report.
"Prepared for U.S. Army Engineer District, Chicago."
Bibliography: p. 27.

1. Cedars Lock and Dam (Wis.) 2. Concrete dams. 3. Dams--Inspection. 4. Locks (Hydraulic engineering). 5. Lower Fox River (Wis.) I. Ahlvin, Joyce C. II. United States. Army. Corps of Engineers. Chicago District. II. U.S. Army Engineer Waterways Experiment

Stowe, Richard L.
Condition survey of Cedars Lock and Dam : ... 1982.
(Card 2)

Station. Structures Laboratory. III. Title IV. Series: Miscellaneous paper (U.S. Army Engineer Waterways Experiment Station) ; SL-82-4.
TA7.W34m no.SL-82-4

LME
-8